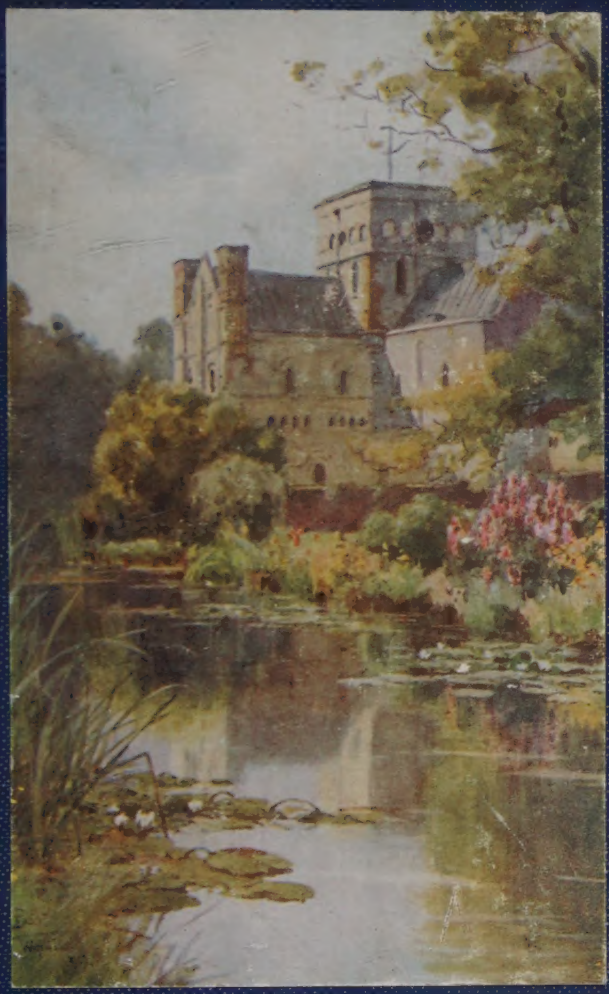
POND LIFE



PEEPS AT NATURE

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EDITED BY

THE REV. CHARLES A. HALL, F.R.M.S.

VIII. POND LIFE

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SOME PLANTS OF THE POND

(1) Great Water Plantain
(2) Yellow Water Lily
(3) Water Crowfoot
(4) Arrowhead
(5) Water Soldier

POND LIFE

BY

REV. CHARLES A. HALL, F.R.M.S.

AUTHOR OF
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PREFACE

A POND, with its peculiar flora and fauna and, withal, so self-contained and restricted in area, provides material of fascinating interest to the naturalist. It is compact and can be easily "worked"; it has well-defined limits, and can be examined under all climatic conditions and during all seasons. Yet small as a pond may be, it is likely to yield an abundance of living objects; and to write an exhaustive account of them all, or even a part of them, would involve the production of a very large volume. This little book does not profess to be more than a "Peep," and in writing it I have thought of that ever-increasing number of young people, and, perhaps, some "grown-ups," who may be in a position I was placed in many years ago, when I wanted to know something about the more outstanding plants and animals associated with the pond. Perhaps no volume I have hitherto written has been such an exercise in self-restraint; there is so much matter that I have had to rigidly exclude. My difficulty has been to select fairly typical subjects out of the pond's abundance, and also to decide what facts I should state about them when there are so many facts of superlative interest that might be stated.

I should like to have added hints on the use of the

microscope and the management of an aquarium, especially as the microscope is essential in the examination of the smaller forms of plant and animal life that are so numerous in the pond; and because it is necessary to keep an aquarium if one is to observe the habits of aquatic animals. As space has not admitted of my carrying this wish into effect, I venture to refer the reader to two books—"Freshwater Aquaria" by the Rev. G. C. Bateman, and my own "How to Use the Microscope."

I desire to express my gratitude to Messrs. W. Watson and Sons, Ltd., for loan of the exquisite microscopical preparation from which the photograph of *Lophopus*, which appears on Plate VII., has been prepared, and also to Messrs. Watkins and Doncaster, London, for so kindly arranging and loaning the insects from which Plate VIII. has been made.

CHARLES A. HALL.

MEIKLERIGGS,
PAISLEY, 1913.

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* These eight illustrations are in colour, the remainder are in black and white from photographs.

FIG. 1.—ALDER-TREE.
Branch, with male and female catkins; 2, female flower; 3, male flower.

FIG. 2.—MEADOW-RUE.

FIG. 3.—MEADOW-SWEET.

FIG. 4.—PURPLE LOOSESTRIFE.

POND LIFE

CHAPTER I

THE VEGETATION OF THE POND

It is hardly necessary to state the obvious fact that the rain-water which descends upon the earth is apt to collect in depressions of the surface; naturally we should not expect it to behave otherwise. But if the soil upon which the water descends be sandy, loose in texture, or friable, and particularly if the subsoil be similarly permeable, the water will quickly filter through it until it reaches a bed of clay or hard rock: not being able to pass through such impermeable material, it will travel along its surface and issue—perhaps a considerable distance from the locality where it falls—in the form of a spring. The spring may give rise to a stream, or, under certain conditions, a pond. But the kind of pond we have in mind at present is usually formed in a depression of a marly or clay soil, and the water is collected from higher ground, down which it trickles in time of rain. The water as it passes over the ground collects fine particles of soil which are urged downhill and deposited

in the pond; and it also dissolves certain salts, which are carried in solution. By both these means the pond is enriched and enabled to provide for abundant plant and animal life. Clay makes an excellent bed for a pond, because, being impermeable, it "holds" water. In a very rainy season the pond may exceed its usual limits; but under normal conditions it is kept within bounds by evaporation. In an unusually dry season evaporation may exceed water-supply and the pond be much reduced; but it is generally found in these moist islands of ours that the supply of water in the form of rain makes good the loss by evaporation.

The pond we are to consider is of the "lowland" type, with stagnant, or nearly stagnant water rich in dissolved salts, which nourish a considerable variety of plants of the aquatic and semi-aquatic type. Ponds, lochs, or lakes of the "highland" type, formed on a bed of hard and comparatively insoluble rocks, and supplied with water which flows over rocks of the same nature, do not yield so luxuriant a vegetation as lowland ponds, probably because they are poor in dissolved salts; but such waters support an interesting association of plants, which, however, cannot be considered in the present volume. But it should be mentioned that a pond of the lowland class may be found amid suitable surroundings at a fairly high altitude; and the highland type may appear within a lowland range. The difference in the plant life is due more to richness or poverty of food than to actual height above sea-level. Pools occurring in the midst of barren moorlands are colonized by plants

characteristic of highland lakes, simply because such pools are poor in dissolved salts.

The student of the plant life associated with a lowland pond will observe that there are certain plants which flourish in the moist or swampy ground at the margin of the water, and also that others are rooted in the mud at the bottom of the pond and entirely submerged. There are also plants rooted in the bed which have floating leaves, and others which raise their leaves and flowers above the surface. In addition, there are a number of plants, many of them microscopic, which either float upon the surface or pass a free, unattached existence within the water. We shall not attempt to catalogue the various species of these different types, but we propose to draw attention to a few in the hope that the reader will be led to prosecute a more detailed study with the assistance of a more advanced volume.

Of plants which assume the proportions and characteristics of trees, the Alder (Fig. 1, p. viii) and some species of the Willow kind are often conspicuous on the margins of ponds. The Alder (*Alnus glutinosa*) grows to moderate proportions, attaining an average height of about 40 feet. It is of dark and sombre hue; its bark is nearly black in colour, and full of clefts. The leaves are dark green; in shape broadly ovate or almost round, and generally wedge-shaped at their base. Sometimes they bear little tufts of down on the under side in the axils of the veins. In the autumn they become dark brown or nearly black, and so they are not gorgeous in their autumn tinting. The flowers are

borne in the form of catkins, and both male and female catkins occur on the same tree. The male catkins are to be found in autumn. They endure through the winter, but do not open and scatter their fertilizing pollen until the spring, by which season the female catkins, which are scarcely half an inch long, are ready for fertilization. The male catkins consist of a string of scales which protect the inconspicuous flowers, three of which are grouped under each scale. These catkins occur in groups of two or three, and when open they are loose and drooping, extending to a length of about 3 inches. They shed an abundance of pollen, which is dependent upon the wind for carriage to the female flowers. The fruiting female catkin somewhat resembles a tiny fir-cone, and the "cones" often persist on the tree long after the seeds, which are small nuts, have been scattered. The wood of the Alder is white while the tree is living, but it turns red on exposure to the air. When dry, it becomes pinkish. A green dye may be made from the flowers, while the bark may be made to yield a dark red dye.

The Willow-tree is too well known to need detailed description. Suffice it to say that we have in Britain about twenty species with numerous varieties. The White or Common Willow (*Salix alba*) and the Crack Willow (*S. fragilis*) are common in moist meadows and and by streams and ponds. The wood of the White Willow is much used in the manufacture of cricket-bats. The leaves of this tree are long, narrow, and, when young, very silky, which gives them a white

appearance. Later they are cleared of down on their upper sides, which then are pale green, and they become whitish when old. The leaves of the Crack Willow are only slightly silky when young, and they present a greener appearance than those of the White Willow. Probably the name "Crack," which is indicated by the Latin *fragilis*, brittle, is due to the fact that the shoots of this tree are easily broken off.

These two Willows, if not pollarded, will grow to a height of about 80 feet; but the Goat Willow, or Common Sallow (*S. Caprea*), seldom attains 30 feet, and most frequently occurs as a bushy shrub. It is also to be seen growing in the moist soil on the margins of ponds. The flowers appear before the leaves, and are popularly called "Palms." They are much visited by bees on fine days in the spring. These flowers are arranged in catkins, the males and females being borne on separate trees.

Among the flowering plants which may be looked for in a zone of saturated soil at the margin of a lowland pond are the following: Meadow-rue, Meadowsweet, Purple Loosestrife, Willow Herb, some species of Mint, Marsh Ragwort, Yellow Loosestrife, Gipsywort, Skull-cap, Marsh Moundwort, Forget-me-not, and a number of Sedges, Grasses, and Rushes. The plants which flourish in this zone love the moist soil, but do not prosper if they are wholly or partly submerged in water. They are adapted for assimilation of carbon dioxide from the atmosphere by means of their leaves, and would be suffocated if submerged.

Meadow-rue (*Thalictrum flavum*) (see Fig. 2, p. viii) is not a common plant; it appears in England and Ireland, and reaches as far north as southern Scotland. It belongs to the natural order Ranunculaceæ, which includes the Clematis, the Anemones, and the Buttercups. It has a short rootstock, from which a stout, furrowed, branched stem arises annually. This stem is purplish-green, and attains a height of 2 or 3 feet. The leaves are fairly large, the petioles, or leaf-stalks, being twice or thrice divided, and the leaves themselves are divided into leaflets; technically speaking, they are twice pinnate. The flowers, which are numerous, are borne in a compact panicle; they have no real petals, but their sepals are yellowish in colour, and their male organs (stamens) are of a more decided yellow. June and July are the flowering months.

Meadow-sweet (Fig. 3, p. viii), or Queen of the Meadow (*Spiræa ulmaria*), is a common and well-known plant belonging to the Rose order. Its numerous, small, sweet-scented, creamy white flowers are massed at the summits of reddish annual stems 2 or 3 feet high. The large leaves are pinnate, the leaflets being green above and downy underneath: the terminal leaflet is larger than the others and cut into three distinct lobes. The rootstock, like that of the Meadow-rue, is perennial. The flowers are to be seen in July and August.

The Purple Loosestrife (*Lythrum Salicaria*) is another of the taller plants to be found in the zone under consideration. It has a perennial rootstock from

which erect stems, about 3 feet high, rise annually. The tapering spires of purple flowers present a beautiful and attractive appearance in July and August. The leaves are 2 or 3 inches long, stalkless, narrow, lobed at the base, and there clasp the stem ; they are opposite in their arrangement on the stem, but occasionally occur in threes (see Fig. 4, p. viii).

Of the species of Willow Herb which affect this moist ground, the most conspicuous is the Great Willow Herb (Fig. 5) or Codlins-and-Cream (*Epilobium hirsutum*). This is a tall, handsome plant, with stout, branched stems, lance-shaped leaves and large rose-coloured flowers. The stems, branches, and leaves are covered with an abundance of soft hairs. This species is easily recognized ; it is known to attain a height of 6 feet, but it will average about 5 feet. The seeds are developed in long, hairy, quadrangular pods.

Fig. 5.—Great Hairy Willow Herb.

The Mints are well known for their peculiar aromatic scent. They belong to the labiate order of plants, which are conspicuous by their square stems, opposite leaves, and two-lipped flowers. There is nearly a dozen species of Mint in Britain, besides a number of varieties ; perhaps the commonest species is *Mentha aquatica*, Water Mint (Fig. 6), and this is often seen on the margin of a pond. It has branched stems, and varies

from 12 to 18 inches in height. The leaves are ovate and stalked; sometimes they are nearly heart-shaped. The lilac flowers appear in terminal clusters, which are very dense, sometimes oblong, often round. Whorls of flowers are also found occasionally below the terminal heads in the axils of the upper leaves. The flowers flourish in summer and autumn.

Fig. 6.—Water Mint.

The Marsh Ragwort (*Senecio aquaticus*) is of the order Compositæ, which includes plants that, like the Daisy and the Coltsfoot, bear "compound" flowers. They consist of numerous florets compacted as a flower-head and enclosed by an "involucre" of bracts, which used to be referred to as a common calyx embracing a compound flower. The Common Ragwort is a sort of bigger brother to the Groundsel; it affects drier situations than its close relative the Marsh Ragwort, with which it is often confused. *S. aquaticus* might, perhaps, be regarded as a descendant of individuals of the Common Ragwort which, in remote times, adapted themselves to moist ground. The Marsh Ragwort is not so tall as its commoner relative, and its flower heads are fewer and larger, nor are they so compact in appearance.

Lysimachia vulgaris, the Yellow Loosestrife (Fig. 7), different as it may seem from the Primrose, yet belongs to the same order, Primulaceæ. It is a tall plant, having branched, downy, erect stems, 2 to 3 feet high. The leaves are usually lance-shaped, and commonly grow in whorls of three or four. The rather large, attractive, yellow flowers are arranged in panicles at the ends of branches, and also issue in a like arrangement from the axils of the upper leaves. This is a frequent plant in England, but rather rare in Scotland. July is the flowering month.

FIG. 7.—GREAT YELLOW LOOSESTRIFE.

Gipsywort (*Lycopus Europæus*) is numbered among the labiate plants. It has slightly hairy, erect, scarcely branched stems, from 1 to 2 feet high. Its leaves are shortly stalked, sometimes ovate, but most frequently lance-shaped, and very deeply toothed. The flowers, which are very small and whitish with purple dots, grow in dense clusters or circles round the stem in the axils of the leaves. It flowers in July and August. This plant is by no means common, but it is frequently found in England and Ireland as well as in southern and western Scotland. Its common name arises from the fact that the juice

of the plant was used formerly by gipsies as a dye for the skin.

Skull-cap (*Scutellaria galericulata*) (see Fig. 8), another labiate, is a weak though otherwise handsome plant, with a slender, creeping rootstock from which stems ascend to a height of 9 or 12 inches. The leaves are heart-shaped at the base, with a generally oblong contour, tapering to a point; they are shortly stalked, and the whole plant is downy. The flowers, which are blue, grow in the axils of the leaves, one from each axil, but so turned that they appear in pairs. The months of July and August constitute the flowering period. This plant is moderately frequent in England and Scotland, but rarer in Ireland.

Fig. 8.—Common Skull-cap.

Fig. 9 represents a further labiate, the Marsh Woundwort (*Stachys palustris*), a plant with long, lance-shaped leaves, serrated on their edges, and rounded or heart-shaped at the base. The lower leaves are shortly stalked, but the upper ones are stalkless. The whole plant is hairy. The flowers, pale purple in colour, grow in whorls of six to eight, and the whorls are crowded into a short terminal spike. This species has little to recommend it to the eye, and less to the sense of smell. Its odour when bruised is decidedly dis-

Yellow Iris

Branched Bur-Reed

agreeable, but not so much so as that of its near relative, the Hedge Woundwort, which, however, is a taller plant and grows in a drier situation. *S. palustris* is a common plant, and occurs locally all over Britain. It flowers in July and August.

The Forget-me-not (*Myosotis palustris*), which affects moist ground, is one of those exquisitely delicate crea-

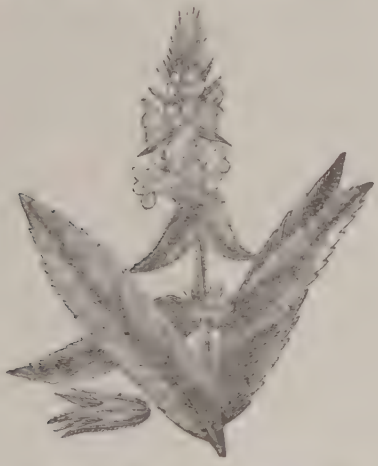


Fig. 9.—Marsh Woundwort.

tions which are dear to the hearts of all lovers of Nature and beautiful things. There are several plants which have been claimed as Forget-me-nots, among them being the Scorpion-grasses, the Speedwell, and the Alkanet; but the genuine Forget-me-not is the plant under notice. It has a perennial creeping stock from which weak stems ascend to an average of a foot high. The stems are frequently clothed with spreading hairs, but they are sometimes almost hairless. The leaves are

generally rough with hairs, and are bright green in colour; in shape lance-like, but blunt at the apex. The delicate blue, yellow-eyed flower is known to all wanderers along the by-paths of the country.

The plants just described are all perennials—that is, they last for several years; but in the same zone of moist soil at the margin of the pond we may find some annuals which, of course, last for one season only. Among these mention is made of three—the Celery-leaved Buttercup, the Marsh Lousewort, and the Toad-rush.

Next to the zone with which the above-mentioned plants are associated there comes a zone of ground covered with shallow water at the edge of the pond in which other plants flourish. These plants are, as it were, ankle-deep in water, sometimes perhaps knee-deep. Among them we may look for the Iris, Bur-reed, Flowering Rush, Spearwort, Brook-lime, and Amphibious Persicaria.

The Yellow Iris, or Flag (*Iris pseud-acorus*), is as bonnie a plant as one need ever desire to see. Surely there is little need to describe this stout, bold beauty, with its sword-shaped leaves and handsome yellow flowers. In the Iris we have a plant which does much to glorify and sweeten a habitation which without it would certainly be more drear and unsavoury.

The Branched Bur-reed (*Sparganium ramosum*) seen from a distance might be mistaken for the Iris; but it is really quite a different plant. It has an erect stem, branched above, some 2 feet high, and sheathed below

by the broad bases of the leaves, which are long and sword-like. The flowers are vastly different from those of the Iris. They are very small, and compacted into globular heads, which appear greenish-white when fully grown. These heads are arranged in a sort of panicle at the top of the stem, as shown on Plate II. This is a very common plant in suitable situations. It flowers in July.

More conspicuous in June or July is the Flowering Rush (*Butomus umbellatus*), for at that time it bears a big umbel of beautiful rose-coloured flowers at the summit of a long, round, leafless stalk, which reaches 3 or 4 feet above the surface of the water. The leaves are long and sword-like. But this handsome plant is not widely distributed in Britain. It occurs in the Midlands and South of England; in northern England and Scotland it appears only as an introduced species.

Fig. 10.—Greater Spearwort.

There are two Spearworts to be found in the zone we are now considering — the Greater Spearwort (*Ranunculus Lingua*) and the Lesser (*R. Flammula*). These are plants of the Buttercup order. *R. Lingua* (Fig. 10) has an erect stem, reaching 2 to 3 feet in height, with hollow branches. The leaves are undivided, stalkless

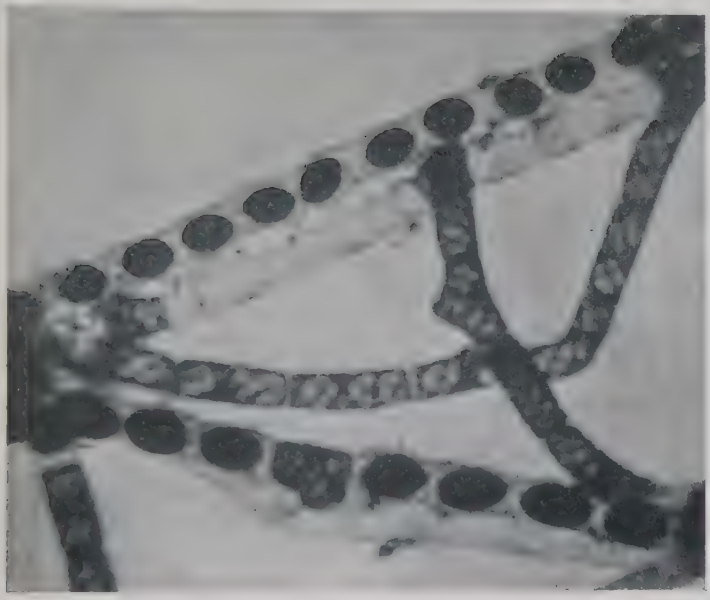
and narrow. The bright, shining yellow flowers, which are more than an inch in diameter, and appear in the summer, are easily observed. It is not a common plant, but its near relative, the Lesser Spearwort, is abundant in Britain. It is not so tall as *R. Lingua*, and its buttercup-like flowers are comparatively small, the majority of them being less than half an inch across.

The Brook-lime (*Veronica Beccabunga*) is of the Speedwell order, closely related to the lovely little Speedwells of our hedgerows, but quite different from them in its succulent, procumbent stem and branches, as well as in regard to its thick, glossy leaves. The whole plant (see Fig. 11) is destitute of hairs, and betrays its aquatic habit. The small blue flowers are borne in opposite racemes, the stalks of which rise from the axils of the leaves. This is a common plant, and flowers throughout the summer. I have known its leaves to be mistaken for those of the Watercress.

FIG. 11.—BROOK-LIME.

As its name implies, the Amphibious Persicaria (*Polygonum amphibium*) can adapt itself to land and water conditions. As an aquatic plant it has floating leaves, quite smooth, borne on stems 2 or 3 feet long ; but when it grows on land its leaves are rough and the stems comparatively short. The rose-coloured

(1)



(2)

(1) *Spirogyra* (much magnified), showing normal strands and others which have formed "zygotes" after conjugation

(2) Diatoms, *Pinnularia maior* (much magnified)

flowers are very small, but they are massed in solitary terminal spikes and so rendered conspicuous.

Rising out of the deeper water of the pond, but rooted in its bed, we may see such plants as the Water Plantain (*Alisma Plantago*), the Water Dropwort (*Œnanthe fistulosa*), and the Arrowhead (*Sagittaria sagittifolia*). There may also occur, if the water be not too deep, the Great Reed-mace (*Typha latifolia*) which is commonly mis-named "Bulrush." The well-known yellow and white Waterlilies (*Nymphæa lutea* and *Castalia alba*) have characteristic large floating leaves. The flower of the Yellow Waterlily is globe-like and slightly raised out of the water; it is much smaller than that of the handsome white species, which remains beneath the surface in twilight and darkness, but under the influence of light and sunshine it rises above the water and expands. This lovely flower is a prize not easily captured without the aid of a boat. A very common rooted aquatic plant which we must not fail to notice is the Water Crowfoot (*Ranunculus aquatilis*). This has an entirely submerged stem, which bears, below the surface, a number of leaves cleft into hair-like segments; but there are also floating leaves quite different from the submerged ones, and these are round or kidney-shaped, and lobed. The pretty white flowers hold their heads just above the surface, and certainly add to the beauty of a pond. The Ivy-leaved Crowfoot (*R. hederaceous*) occurs nearer the edge of the pond, and often on mud uncovered by water. Its leaves are all broadly kidney-shaped.

The Common Duckweed (*Lemna minor*) does not root in the soil. It floats freely on the surface of the water ; its tiny leaves, three or four in number, are joined, and a fibre, in place of a root, descends from them into the water. It is a flowering plant, but the flower is very inconspicuous. On some ponds this weed is often so abundant as to cover the surface, and prevent the growth of other plants by withholding light from them. There are other species of Duckweed which we do not propose to notice here.

The Bladderworts (*Utricularia vulgaris* and *U. minor*) are remarkable floating plants. Having already described them in "Wild Flowers and their Wonderful Ways," a volume of the "Peeps at Nature" series, it is hardly necessary for me to treat of them at length here. Suffice it to say that they are found floating in ponds and ditches in which tiny animalculæ abound. Their branches and leaves are all submerged, the leaves being divided into hair-like segments. They send up into the air a few flower-stems, each about 6 inches long, which bear rather handsome yellow flowers. The name "Bladderwort" is due to numerous little green vessels, or bladders which are borne among the segments of the leaves. The older botanists thought that these vessels were floats, but it has since been discovered that they are traps for the capture of animalculæ. Minute crustaceans, such as Water-fleas and Cyclops, (see p. 57) are common prey of these plants. The animals can get into the traps quite easily, but when they try to get out they find that the door has been closed against them.

PLATE 4

(1) Water Boatman
(2) Great Water Beetle
(3) Larva of Great Water Beetle
(4) Brown Water Beetle (Male)
(5) Brown Water Beetle (Female)
(6) Larva, Brown Water Beetle
(7) Water Scorpion

They soon exhaust the oxygen from their prisons and consequently die. Their bodies become macerated, a sort of broth is formed, and this is absorbed by the plant which is much profited thereby. Thus the Bladderworts are carnivorous plants ; they are widely distributed in Britain, but not common ; they flower in the summer.

Another floating plant, the Common Hornwort (*Ceratophyllum demersum*) (see Fig. 12), is fairly

FIG. 12.—COMMON HORNWORT.

common in British ponds as well as in slow running streams. Like other plants of similar habit, it assimilates its nourishment entirely from the water in which it lives. It has narrow, forked, somewhat bristly leaves, which grow in whorls round the stems, and are rather densely massed. The inconspicuous green flowers grow in the axils of the leaves.

Among plants which root at the bottom of the pond and are entirely submerged mention is made of two, the American Water-weed or Water-thyme, and the Curled Pond-weed.

The American Water-weed (*Elodea Canadense*), sometimes known as *Anacharis alsinastrum*, as its common name implies, is of American origin. It found its way into Britain from America, it is thought, on imported timber. It was first noted in this country in 1847, when it appeared in Leicestershire, Yorkshire, and Berwickshire ; now it is a common weed in our canals, slow streams, and ponds. This plant has numerous, small, transparent, stalkless leaves which grow in whorls of three or four around the brittle stem. In our country it seems to increase by the growth of disjointed fragments, not from seed. The living leaves, examined under the microscope, display a curious protoplasmic movement in their cells ; this movement is termed "cyclosis."

The Curled Pond-weed (*Potamogeton crispus*) often constitutes an undergrowth at the bottom of a shallow pond. It has a compressed stem, sometimes 2 or 3 feet long. Its leaves are arranged alternately on the stem. They are lance-shaped, waved or crisped, and serrated on their margins, attaining a length of nearly 2 inches. The elongated flower stalk bears from three to six small flowers in summer-time. This plant (see Fig. 13) is common in Britain, and is one of a genus which embraces more than a dozen native species.

The Water-soldier (*Stratiotes aloides*) is common in

the English Fens, but rare, or non-existent, in other districts of Britain. The whole plant is submerged except at the flowering season, when it rises to the surface. It gets its common name from its sword-like leaves, which are stalkless, long, narrow, succulent, and armed with small teeth. The flowers are rather showy. They are raised on a stalk a few inches above the surface

Fig. 13.—Curled Pondweed.

of the water. Each flower has three green sepals and three delicate white petals. July is the flowering month.

Beyond a certain depth we do not find any of the more highly organized plants; it is only in shallow ponds that we find the entire bottom colonized by such vegetation. In deep water light does not penetrate with sufficient intensity to admit of its growth ; it is only microscopic bacteria which can thrive in the profounder, darker depths.

The mention of such microscopic plants as the bacteria reminds us of the host of minute plants, very low in the botanical scale, which are common in water, and which are so small as to need microscopic examination. Minute as they are we must find some space for their mention, otherwise our little volume would fall short of its purpose.

The plants we have in mind are grouped among the Algæ, which, as everybody knows, include the sea-weeds.

Filamentous or thread-like green Algæ will be found in every pond and everywhere where there is damp ground, or water is allowed to stand. In our pond they may be seen growing in submerged, delicate, woolly green masses, or attached to stones, floating objects, or other vegetation. Sometimes they form a kind of green scum on the surface. In running water they may be seen as long, thread-like waving strands. If we examine a few strands under a moderate power of the microscope, we can see that each filament is made up of single cells placed end to end. We can note the cell-wall and the cell-contents, including the green colouring matter, the vital nucleus, and the protoplasm. The species of filamentous Algæ are very numerous, but as types we will mention *Spirogyra*, *Zygnema*, and *Draparnaldia*. In *Spirogyra* the colouring matter is arranged in spirals along the length of the cells. In *Zygnema* the arrangement is in the form of two somewhat star-shaped green bodies in each oblong cell. Both these plants produce spores, from which new individuals arise in a rather remarkable manner. Two individual

filaments come into near proximity, and from their sides tiny processes are developed. These processes, which are protuberances of individual cells, meet and unite. A passage is formed from one cell into the other, along which the cell-contents pass, spores resulting from this conjugation. A photograph reproduced on Plate III. illustrates the process and results of conjugation in *Spirogyra*. Prior to conjugation the cells become filled with green matter, and thus the characteristic arrangement and appearance of this matter in the two species under notice is lost at this peculiar crisis.

Draparnaldia glomerata loves clear water, and is often found in slow streams. It grows attached to water-weeds. It has main filaments from which tufts of branches develop. The main filaments consist of large cells arranged end to end. They are colourless and transparent, except for a band or ring of bright green colouring matter in each one. The tufted branches are composed of smaller cells, rather bead-like in appearance, the terminal cell always ending in a point or bristle.

Desmids and Diatoms are also among the microscopic Algæ, and are remarkable in several ways. They are both extremely simple orders of plants, being composed of a single cell, and are therefore exceedingly minute. Desmids are found in some ponds, but they certainly thrive better, and thus are more commonly found, in open situations, such as moorland pools and in highland lochs. Some are found free in the water and can be secured with a fine net, which should be

made of "mull" muslin; others are attached to plants or the muddy bottom of the pool. Sunlight generally attracts them to the surface. When they are very numerous they give a green tint to the water. They exist in many kinds, all of which make fascinating microscopic objects. When we examine them under a moderate power we can see that each Desmid is unicellular; that the cell has a distinct cell-wall which, while exceedingly thin, is quite firm. Next to the cell-wall, on the inside, is a layer of colourless protoplasm, and within this is the "endochrome," which is a mass of matter coloured a brilliant green by chlorophyl. In Desmids the endochrome is always divided into two distinct halves. The brilliant green coloration is one of the most noticeable and attractive features of those plants. In some species spines or points project from the cell-wall.

We have space to describe but one Desmid—*Closterium lunula*—which is one of the commonest species and very beautiful. It is long, narrow, and bow- or crescent-shaped. The cell-wall is marked with longitudinal flutings, but is smooth at the points and at the narrow band in the middle. The endochrome, which, of course, is in two halves, occupies the greater part of the cell, but at each end there is a transparent space containing tiny globular particles which are in a state of motion. Peculiar protoplasmic movements may be observed within the cell. *Closterium* reproduces in two ways: in the first and simplest it divides at the middle, and two full-grown plants develop from each half; in

the second, two individuals draw together and become united at their convex sides. The result of this union is the formation of a cavity into which the contents of both cells flow. A round sac with a cell-wall is developed. This is termed the "sporangium," or "zygospore," and within it spore bodies mature and in time give rise to new plants.

Diatoms are to be found in almost any moist situation, and it would be a poor pond indeed that did not yield an abundant quota. Their number and variety is legion. Small as they are, each consisting of a single cell, they are able to extract silica from water, and form cell-walls of that material. The flinty "frustules," as they are called, are generally marked with exceedingly fine lines and pits. They make beautiful objects for microscopic examination, some of the frustules being used as objects for testing the resolving powers of lenses. The frustules, being composed of silica, may be subjected to a very high temperature without being destroyed. Each cell has its flinty shell composed of two parts, one fitting over the other like the flanged lid of a box. Inside the shell is the endochrome, which is brownish-yellow, not green as in the Desmids. Diatoms increase by longitudinal sub-division. New valves are formed inside the old ones, and are arranged so that the inside valve of the parent plant becomes the outside valve of a new one. Another method of multiplication occurs, but its details are not yet fully understood.

There are free-swimming Diatoms, Diatoms that occur in chain-like series ; others are stalked ; and, again, others

are found in filaments of gelatinous matter. Of the free-swimming group, *Pinnularia* is a genus which includes some of our handsomest fresh-water Diatoms (see Plate III.) ; they are of good size in comparison with other kinds, and some of the species have the merit of being common. They are oblong or oval in form, and the frustules are ribbed with transverse lines, which terminate before they reach the centre. A smooth central area is divided by a line running lengthwise ; in the centre there is a tiny knob. The *Naviculæ* (little ships) are also free-swimming, very numerous, some species being particularly common. They are somewhat boat-shaped, hence their name. It is interesting to observe the movements of the free Diatoms ; they may be, as it were, steaming ahead in a straight line, but on meeting an obstacle they will "reverse engines," or tack. *Diatoma vulgare* occurs in chain-like series ; the square or oblong frustules with their curious markings are connected with each other, corner to corner, by tiny balls of flexible substance. Diatoms may be found attached to water plants of larger growth, on the mud at the bottom of the pond, among the thread-like Algæ, in masses on submerged stones or floating timber, and in other situations.

We conclude this chapter with a rapid description of a very remarkable organism, which zoologists claim to be an animal, while botanists declare it to be a plant. I range myself on the side of the botanists. If we are fortunate in pond-hunting we may find in our collecting bottle a number of tiny green, whirling globes, which

Dragon Fly *(Æschna cyanea)*

(1) Larva
(2) Larva with extended "mask"
(3) Pupa creeping out of water in preparation for "change"
(4) Perfect Insect

can be detected with the naked eye. They are specimens of *Volvox globator* (Fig. 14). Examined with a good pocket magnifier, *Volvox* will display a few smaller globes inside itself. Under a higher power of the compound microscope we can see that this wonderful plant is really an aggregation of tiny cells connected by strands of protoplasm, which give a network appearance. Each cell bears very fine hairs called "cilia," and it is by means of these that the colony swims. The smaller enclosed globes are colonies in process of development ; in time they are liberated by the bursting of the parent globe, after which they go on their way rejoicing, and grow to full size, in time becoming parents to other colonies. *Volvox* is not to be found in every pond ; it seems to thrive in fairly clear water. It is extremely delicate, and highly sensitive to changes of temperature.

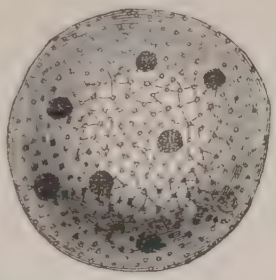


FIG. 14.—VOLVOX GLOBATOR (Müller). MAGNIFIED.

CHAPTER II

PROTOZOA, OR PRIMITIVE ANIMALS

WE proceed from a rapid "peep" at the plant life to be found in and near a pond to a glance at some of the simplest and lowliest animals which are discoverable in Nature. From remarks made at the conclusion of the

previous chapter in regard to *Volvox globator*, it will be gathered that the dividing line between the vegetable and animal kingdoms is not easily determined. However, the life-forms now to be described are undoubtedly animal ; they are all one-celled organisms, microscopic in proportions, and " live, move, and have their being " in water ; only such forms as are to be found in a pond are mentioned. Their number is legion, and only typical forms can be dealt with in our limited space.

The Protozoa (Greek, *protos*, first ; *zoon*, animal) are practically ubiquitous ; Ehrenberg, an early observer of these humble animals, wrote : " In the clearest water and in muddy pools, in acid as well as alkaline waters, in brooks, lakes, rivers, and seas, often also in the interior fluids of living plants and animals, abundantly in living men, and periodically borne on the dust and vapours of our atmosphere, there exists a world, unknown to the ordinary senses of man, of minute, peculiar forms of life." Ordinarily, we are unaware of the existence of the life-forms referred to, but the use of the microscope enables us to realize that there is in our world, and its atmosphere, a teeming population which we cannot detect with the unaided eye.

As already indicated, each one of these primitive animals is a single cell ; and it is to be noted that the cell consists of protoplasm, that living matter which is the basis of both vegetable and animal life. The body of a protozoön is a tiny protoplasmic cell ; the body of a man is a complicated organization of myriads of cells made from protoplasm, and there is no very conspicuous

(1)

(2)

(1) Hydra with bud. Photo from microscopical preparation. × 20

(2) Female Water-Flea (*Daphnia pulex*), showing eggs in brood chamber. Photo from microscopical preparation. × 45

difference between the protozoic cell and the individual cells of the human body. But in our bodies the cells are organized to act together in specialized functions, whereas the single cell of the protozoön performs all the functions of the creature's life. It attends to the business of food-getting, of digestion, excretion, movements, and reproduction. It is not particularly comforting to know that certain protozoa infest the tissues of our bodies and live there as parasites: we marvel that they can exist in such dark, airless quarters, and can take heart when we realize their exceeding smallness in proportion to our bulk, and that it is only when they take up residence *inside* the tissue cells that they do serious damage. Those forms which exist *among* the cells, not entering into them, are practically harmless.

But our present concern is with the Protozoa of the pond, and it is proper and orderly that we should take as our first example the wonderful *Amœba proteus* (Fig. 15), that living speck of protoplasm which can assume many forms without having any definite form. It can creep by means of feet extemporized at a moment's notice; push out feet from its body mass—feet which can be retracted as desired, and when retracted are no longer feet, because they have been absorbed by the mass. It can also perform marvellous feats of digestion without having a stomach, to say nothing of its ability to swallow in the absence of a mouth.

Amœba is rightly considered first, because in the

classification of the Protozoa this organism is placed in the first order, the Lobosa (Greek, *lobos*, a lobe), which embraces those simple animals which are capable of forming pseudopodia, or false feet ; the feet, or pseudopods, of the Lobosa are always blunt and lobe-like. "*Amœba*" is the name of a genus, or kind, which includes several species. *Amœba proteus* is a particular species of the genus *Amœba ;* the specific name reminds

FIG. 15.—THE PROTEUS-ANIMALCULE (*AMŒBA*), SHOWING NUCLEUS (*n*) AND CONTRACTILE VACUOLE (*c.v.*).

One end of the body is distended by a large diatom.

one of the fabled sea-god, Proteus, declared to have the power of assuming an endless variety of forms.

This protean animal is to be found wherever water stagnates ; although the novice may have difficulty in finding it, it is certain to exist on the surface of the mud, amidst decaying matter, on the bottom of the pond. It usually turns up in tubes of pond water containing decaying vegetable matter ; and it frequently

appears in "infusions"—that is, vegetable or animal matter covered with water in a shallow vessel and allowed to decay. In size it may vary from less than one-hundredth to more than one-fortieth of an inch in diameter.

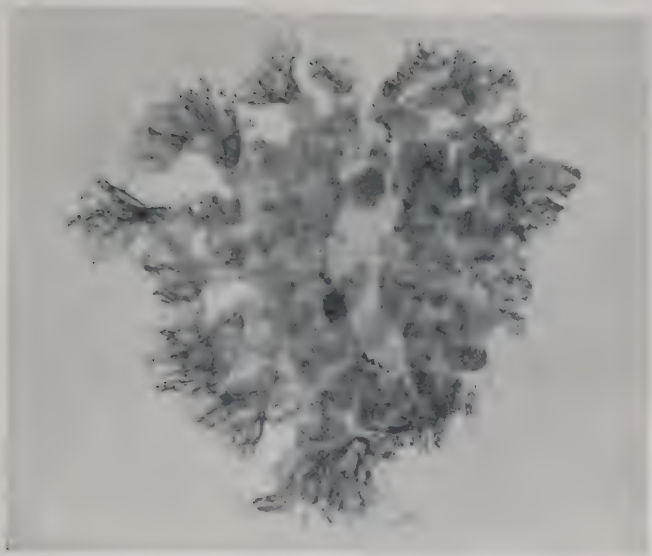
Under the microscope *Amœba proteus* appears like a tiny mass of almost transparent jelly, which, when active, is constantly changing its shape. The inner substance of the protoplasmic mass includes tiny particles of solid matter, but round this so-called "granular" substance is a practically transparent margin, or rind. The rind, called the ectoplasm, while very elastic, is less fluid than the inner granular substance, which is known as the endoplasm. It is common to see in the endoplasm remains of minute plants, even Diatoms, as well as particles of sand.

Probably if we examine *Amœba* immediately after transferring it to the stage of the microscope we shall see it in an almost spherical form, but if the specimen is healthy it will soon display its protean peculiarities. Feet are formed from projections of the transparent ectoplasm into which some of the granular endoplasm flows. The extension of these feet enables the creature to change its position; as the feet are extended the remainder of the body mass is drawn after them—so the animal "walks." If eating is the purpose to the fore, and desirable food is available, "feet" embrace the succulent morsel, which is soon engulfed in the body mass, there to be digested in a temporarily-made stomach known as a food vacuole. One may also be

fortunate enough to see in the body mass a clear globular space, which gradually becomes larger, and then quickly disappears; this is the contractile vacuole, which probably has something to do with excretion. Another round body may also appear in the endoplasm; it certainly will appear if the animal is killed and stained, say, with iodine; this is the nucleus which is essential to the life of the animal. Without a nucleus, in some form or other, no cell can live; it is the vital centre. If it is removed, the remaining protoplasm becomes inert; while, on the other hand, no nucleus can exist if isolated from the protoplasm to which it is essential. *Amœba* has tremendous vitality, in which respect it is similar to other protozoa. Doubtless if we could manage to cut it into fifty pieces, each piece would live and grow if it included a fragment of the original nucleus.

When the water in which *Amœbæ* live dries up the animals do not necessarily die. They draw in their feet, assume a spherical form, the ectoplasm of which becomes hardened, and so protects the endoplasm. This hardened exterior is called a "cyst," and the process just mentioned is "encystment." On the return of favourable conditions—that is, on again being covered with water—the cyst is softened, and the animal can resume its normal activities. In the encysted state *Amœbæ* may be taken up by the wind, as so much dust, and carried long distances, to be ultimately deposited, not "in fresh woods and pastures new," but in some pond or pool where they can resume their sluggish but interesting existence. The mode of reproduction is of

(1)



(2)

FRESHWATER POLYZOA

(1) Young colony of *Cristatella mucedo*. Photo from microscopical preparation. × 10.

(2) *Lophopus crystallinus*. × 8

From microscopical preparations kindly lent by Messrs. W. Watson and Sons, Ltd

the simplest kind—it is called "fission." The creature divides into two, and then there are two active *Amœbæ*, which, in due season, will repeat the process—and so on *ad infinitum*.

Several species of the genus *Difflugia* (Fig. 16), also belonging to the Lobosa, are to be found amongst the vegetation and in the mud of ponds. *Difflugiæ* are protozoa of the *Amœba* order which occupy a protective case, or shell. They, like *Amœbæ*, protrude pseudopodia; but because the animals occupy shells with a single opening, or mouth, they are obliged to extend their pseudopodia through that opening. The shell is called a "test," which consists of inner and outer sheaths. The outer sheath is covered with grains of sand, or, in some cases, with diatom shells, and it is said that the animal catches and arranges the materials, making a deliberate selection of the particles it favours. The test is generally flask-shaped. Some of the larger species of *Difflugia* are about one-fiftieth of an inch in length.

FIG. 16.—*DIFFLUGIA PYRIFORMIS*, PERTY, WITH VERY LARGE DIATOM SHELLS ATTACHED TO THE TEST. (*After Leidy.*)

The genus *Arcella*, again classed with the Lobosa, differs from *Difflugia* in that, instead of occupying a flask-shaped shell covered with foreign particles, the animals secrete a shell in form somewhat like a miniature watch-glass with its margin produced inwards, but

pierced with a round hole. Through this hole the amœboid animal thrusts its pseudopodia. The shell is composed of chitin, the substance from which the wing-cases of beetles are formed. *Arcella vulgaris* (Fig. 17) is common in stagnant water; it is considerably smaller than *Difflugia*.

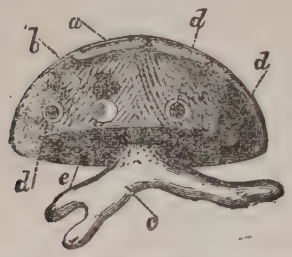


FIG. 17.—*ARCELLA VULGARIS* (Ehrb.).

a, Shell; *b*, protoplasm within the shell; *c*, lobose pseudopodia; *e*, one of the marginal vacuoles; *d*, nuclei surrounded by a halo of clear protoplasm. (*After Lankester.*)

Actinophrys sol, the "Sun Animalcule" (Fig. 18), is classed with a more advanced order of the Protozoa, the Heliozoa (Greek, *helios*, the sun). The drawing indicates the reason for the technical name. Under the microscope the animals are seen to send out pseudopodia, which have some likeness to conventional drawings of the sun's rays. These extemporized feet, relatively long, stiff, and ray-like, are projected from a spherical body; they are usually set and motionless. But when the floating speck discovers desirable food, such as a minute infusorian or rotifer, it is seized by one or more of the pseudopods, firmly held thereby, and pressed inwards to the body mass. The pseudopods bend inwards with the food, which is engulfed by a process of no particular shape, pushed out from the body for the purpose. The animal, although usually seen with extended pseudopods, can withdraw them at will; it does so when irritated. *Actinophrys sol* is very small,

(1) Limnophilus affinis
(2) Phryganea minor
(3) May fly
(4) Leptoceros ochraceus
(5) Paraponyx stratiotata
(6) Hydrocampa nymphæata
(7) Hydrocampa stagnata
(8) Cataclysta lemnata

N.B.—1, 2 & 4 = Caddis-flies
5, 6, 7, 8 = Moths

being about one-thousandth of an inch in diameter. It has one nucleus. It is common in ponds among floating scum and conferva. *Actinosphærium eichornii*, a much larger organism, is found in similar situations, and belongs to the same order; it can be just seen with

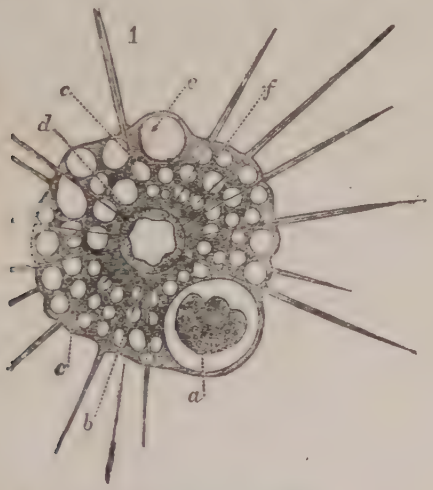


FIG. 18.—*ACTINOPHRYS SOL* (Ehrb.). ×800.

a, Food-particle lying in a large food vacuole; *b*, deep-lying, finely-granular protoplasm; *c*, axial filament of a pseudopodium extended inwards to the nucleus; *d*, the centrally-placed nucleus; *e*, contractile vacuole; *f*, superficial, much vacuolated protoplasm.

the naked eye. On examination under the microscope it exhibits numerous pseudopods and about 200 nuclei.

A large and interesting group of Protozoa is composed of flagellated organisms — one-celled animals, numerous and varied, distinct in shape, and possessed of one or more long, whip-like processes called "flagella" (Latin, *flagellum*, a little whip). *Euglena viridis* (Fig. 19)

is a flagellate, and an exceedingly common one. We are sure to find specimens in any standing pool or pond ; it frequently exists in such enormous numbers as to give water a green appearance. Yet it is seldom more than one-hundred-and-fortieth of an inch in length, and is often much smaller. The body, generally speaking, is cigar-shaped, but it can assume various temporary forms. The endoplasm is brilliantly green from the presence of chlorophyll, the green colouring matter which is found in plants. At both ends of the body, head and tail, there is a colourless region. A single flagellum, as long as the body, exceedingly transparent and difficult to detect, proceeds from a minute mouth cavity. The animal swims, or is drawn through the water, by a rotatory lashing motion of the flagellum comparable to the motion of the propeller of an æroplane. The lashing of the water also causes a miniature whirlpool which forces food into the mouth cavity. At the head end is a bright-red pigment spot. Minute granules which are found in the endoplasm are very like starch, and their presence combined with that of the chlorophyl indicates that the animal can elaborate food after the manner of green plants, as well as feed in the characteristic animal fashion. Perhaps it were wise

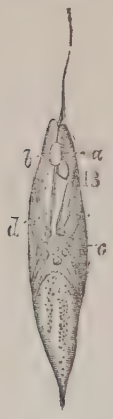


FIG. 19.—*EUGLENA VIRIDIS* (Ehrb.). *a*, Pigment spot; *b*, flagellar reservoir; *c*, paramylum granules; *d*, chromatophores.

to call this protozoön a plant-animal. In a resting state *E. viridis* assumes a spherical form. When exposed to the air it encysts like the *Amœba*. It often becomes encysted prior to reproduction, in which event, not one, but many *Euglenæ* may ultimately emerge from the cyst. Multiplication is also effected by simple longitudinal fission. There are several species of *Euglena*; but we must not stay to consider them or any other flagellates, otherwise this volume will never come to an end.

We shall conclude this chapter with a rapid description of a few species of ciliated protozoa, which are genuine Infusoria. The *Ciliata* display a considerable advance in structure. They are certainly unicellular, otherwise they would not be protozoa; but definite parts of the single cell are specialized for distinct functions, and they all possess cilia (literally, "eyelashes"), which are short, hair-like processes very different from flagella. In some instances the cilia cover the entire body; in others they are arranged in bands; sometimes they occur only on the back, or they may appear on the under side, leaving the back clear. Some of the *Ciliata* are free-swimming, in which cases the cilia are the means of propulsion; other kinds become attached to some sort of foothold and live in colonies.

The Bell-Animalcule (*Vorticella*, Fig. 20), a most charming microscopic object, is one of the last mentioned kind. Whole colonies may be found on the roots of Duckweed, or attached to various living plants;

they are also to be got on decaying leaves in the pond. Each member of the colony is a distinct individual, consisting of a cell with a long, transparent, delicate stalk attached to the foothold at one end, and surmounted at the free end by a bell-shaped body. The

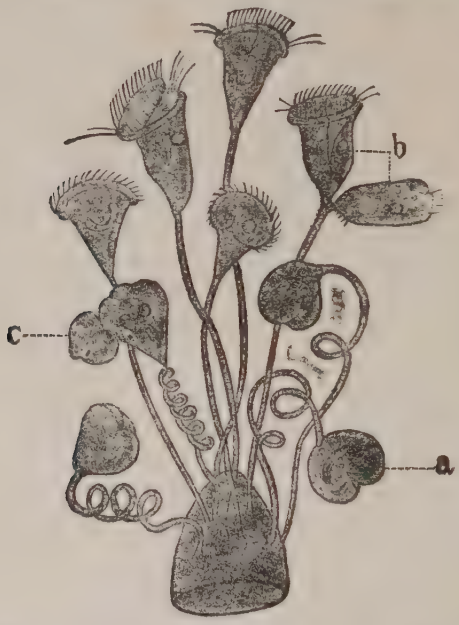


FIG. 20.—*VORTICELLA NEBULIFERA* (Ehrb.).
A social group showing at *a* and *b* successive stages of fissions, and at *c* conjugation. (*After Saville Kent.*)

bell exhibits curious structure; the lip has a broad rim, called the "peristome"; this encircles a disc, which is tilted; there is a depression, or groove, between the disc and the peristome, and the groove leads into a mouth or gullet. Cilia are arranged in

a spiral which fringes the disc, and runs round the inner edge of the groove to the mouth. When the animal is active the cilia wave to and fro, thus causing a vortex for the ingestion of food particles, which are drawn to the mouth in the current of water. When the animal is feeding the foot-stalk is extended stiffly, and the cilia lash the water rapidly ; but if the creature is disturbed the stalk contracts spirally, and the body is drawn back to shelter. It is very interesting to see this contraction ; it is effected very rapidly and suddenly ; nor is it less interesting to observe a half-extended animal with a partly-coiled stalk. Let it be noted that the cilia and stalk of *Vorticella* are permanent ; they are not withdrawn into the body like the pseudopods of *Amœba* or *Actinophrys*.

Vorticella has a distinct nucleus, and a contractile vacuole (see p. 30), but it has no organized stomach ; it digests food after the manner of an *Amœba*. It reproduces by fission ; one individual splits into two, one of which swims about freely until it secures a satisfactory food-hold. Reproduction also occurs after a somewhat remarkable process of conjugation. To the naked eye, *Vorticella* looks like a fine film, or whitish scum, on the vegetation which supports it. It is seen to advantage in water under a moderate magnifying power.

Hardly less attractive than *Vorticella* are the various species of the genus *Stentor*, which are commonly known as Trumpet Animalculæ. *Stentor polymorphus* (Fig. 21) is a large species—if we may call an animal large which

is only a twentieth of an inch long when fully extended. It is found singly, or occasionally in colonies, among both green or decayed vegetation in the pond. Sometimes a *Stentor* attaches itself to a plant, but it is frequently seen swimming freely. The species under notice is usually bluish-green in colour, owing to the presence of chlorophyll in the cell. It is when the animal is fully extended that it exhibits a funnel or trumpet shape; in swimming it assumes many forms, sometimes cylindrical, now spherical, now indescribably distorted. The rim of the trumpet runs in a spiral; it is fringed with cilia. Most, if not all, species of *Stentor* secrete jelly-like sheaths, into which the animals retract when alarmed.

FIG. 21.—*STENTOR POLYMORPHUS* (Müller).

A group of individuals attached to a water-weed. × 50.

The Swan Animalcule (*Trachelocerca olor*), another ciliate, is found among decaying vegetation in the pond. It has a body thick in the middle, tapering quickly to a short point at the posterior end, and extended in front into a long swan-like neck, which is very elastic and capable of contraction. When the neck is fully extended it may be about four times as long as the body. The whole length of the animal is about one hundred and fortieth of an inch. There is a mouth opening at the end of the neck. It is very curious to see these

animals thrusting their swan-like necks amongst vegetation in quest of food. The body is striated and ciliated over its entire surface.

Coleps hirtus, the Barrel Animalcule (Fig. 22), is a common ciliated occupant of the pond, where it is to be found swimming freely among Conferva and Duckweed. As the common name implies it is barrel-shaped, and the name seems all the more appropriate when we see the animal swimming with a rolling motion on its long axis, like a minute animated barrel. For so small a creature—it is about one four-hundredth of an inch in length—it is very rapacious; there seems to be no limit to its appetite, and, fortunately, it is a good scavenger, for it feeds on decaying matter. The body, usually coloured light brown, though sometimes whitish, is covered with a quadrangular network of ciliated ridges. *Coleps* increases by transverse fission; individuals may often be seen constricted in the middle in preparation for fission, and if they are carefully watched the whole process of one individual dividing into two may be seen.

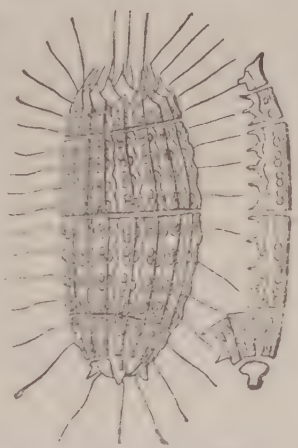


FIG. 22.—*COLEPS HIRTUS* (Ehrb.).
a, One of the fifteen rows of plates.

Of the ciliated Infusorians, the "Slipper Animalculæ" (*Paramœcium*), a free-swimming genus, present

such well-marked features, and are so common, that they are often selected by zoologists for purposes of demonstration. *Paramœcium aurelia* (Fig. 23) can be found in any pond. It has an elongated oval form, a golden-brown colour, and is about one-hundredth of an

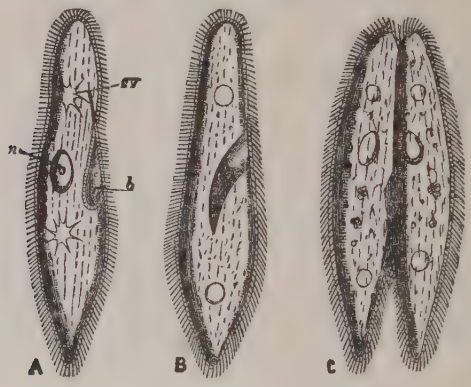


FIG. 23.—*PARAMŒCIUM AURELIA.*

A, Lateral; B, ventral surface; C, in conjugation; *cv*, contractile vesicle; *n*, nucleus; *b*, oral aperture.

inch in length. On one side there is a groove leading to a mouth aperture, which is to be seen near the centre of the body. There are two contractile vacuoles, one near either end. The animal is covered with cilia, which are arranged in lines. A fancied resemblance to a slipper accounts for the common name.

(1) Forget-me-not
(2) Fresh-water Whelk
(3) Ramshorn Snail
(4) Fresh-water Winkle

CHAPTER III

OTHER REMARKABLE DENIZENS OF THE POND

ATTACHED to the stems or leaves of water plants we may find specimens of the remarkable animal known as the Hydra. It is discoverable in many ponds, and several freshwater species are known ; we shall confine our attention to the green species (*Hydra viridis*). In order to secure some of these animals for examination, it is advisable to take tufts of such plants as the Water Crowfoot, or handfuls of Duckweed, from the pond, and insert them in water in a glass jar : if Hydras are present they will soon display themselves. Being of a fair size, some of them attaining upwards of an inch in length, they can be easily seen with the naked eye, but they are better observed with the aid of a pocket-lens or a low power of the compound microscope. The photograph on Plate VI. gives us an idea of the general appearance of this animal. It has a long, narrow tubular body, with a small mouth at one end, whilst the other end is closed and attached to a foothold. Circling the mouth are from six to eight tubular arms, or tentacles, which move in all directions in quest of prey. If the animal is disturbed the tentacles are retracted and the body contracts, and no more is seen than a green jelly-like blob, ornamented with knobs, which indicate the retracted tentacles. The cause of alarm having been removed, the animal will again

extend and prosecute such a quest for prey as can be dictated only by an insatiable appetite.

Water-fleas, to be described in a later chapter, seem to be regarded by the Hydra as particularly dainty morsels. If one of these active creatures comes in touch with an extended tentacle, it will, in high probability, halt in its career, as if suddenly stunned. The tentacle will then bend inwards with its captured prey, and convey it to the mouth ; it is then passed through the mouth into the hollow body, where it is digested, indigestible parts being afterwards expelled. If need be, the elastic body will expand to accommodate a large morsel of food. Small worms and other active animals are stunned by the Hydra, and finally consumed, equally as readily as Water-fleas. If a couple of Hydras, kept in captivity, be starved for a few days, and then a small worm is served to them, they will fight a battle royal for its possession, and provide much entertainment in the process.

The name of this animal will be associated by the reader with the fabled Hydra of Ancient Greece. This monster is alleged to have had a hundred heads, and when one head was lopped off two appeared in its place. It was the all-conquering Hercules who gave this hideous beast its final quietus : the incident is referred to in these lines of Ovid :

> "Art thou proportion'd to the Hydra's length,
> Who by his wounds received augmented strength ?
> He raised a hundred hissing heads in air ;
> When one I lopp'd, up sprang a dreadful pair ;
> By his wounds fertile, and with slaughter strong
> Singly I quell'd him, and stretch d dead along.'

Although the Hydra of the pond has not a hundred heads, and is assuredly a very miniature monster, yet it is well named. It must be monstrous to creatures smaller than itself, and it has a vitality which is most amazing. Let it be turned inside out it will yet live and thrive ; lopped-off tentacles are soon replaced ; if the animal be cut longitudinally into two parts, each part will live an individual existence as a perfect whole. Cut the creature up into a dozen pieces, and most likely each piece will develop into a complete Hydra. Johnston, in his "British Zoophytes," says : "If a section be made from the tail towards the tentacles, you produce a monster with two bodies and one head. If the tentacles are cut away, they are reproduced, and the lopped-off parts remain not long without a body. If only two or three tentacles are embraced in the section, the result is the same, and a single tentacle will serve for the evolution of a complete creature. When a piece is cut out of the body, the wound speedily heals ; when a polype is introduced by the tail into another's body, the two unite and form one individual, and when a head is lopped off, it may safely be engrafted on the body of any other which may chance to want one. And the creature even suffers very little by these apparently cruel operations—'Scarce seems to feel or know his wound.'"

The usual means by which the Hydra reproduces itself is by "budding." The body bulges at a particular place, and a knob-like bud is formed ; this bud produces tentacles, and thus a new individual grows out of the parent. The bud is eventually separated from

the parent, but even while attached to it may capture and digest prey. There is, however, a sexual mode of multiplication. In the late autumn, egg cells are produced, and these are fertilized by active germs, which are expelled into the water, and swim actively like very microscopic tadpoles until they become united with egg-cells, rendering them fertile, and thus capable of growth into fully-developed Hydras. The fertilized egg-cells become covered with a protective coat, drop from the parent into the mud and remain there over the winter ; the young Hydras issue in the spring.

But why is the prey of the Hydra stunned or paralyzed when it comes in contact with a tentacle? If we examine the prey after being thus stunned, we shall find that it has been stung by a peculiar "thread-cell." It appears that such cells are developed in the tentacles ; each consists of a tiny bag containing fluid and a coiled hollow thread ; the body of the cell is continued outwards into a trigger-like process. When the prey touches the trigger, the pressure is sufficient to release it, and then the coiled thread shoots out, piercing the body of the victim, and paralyzing it with a poison.

Microscopic examination reveals the fact that the Hydra is a many-celled animal. The body is built up of a layer of cells forming a distinct ectoderm, or outer wall, and it is among these cells that the thread-cells just referred to are developed ; there is also an inner layer of endoderm cells, each crowned with tiny thread-like flagella. The body is hollow, and it is in the body cavity that digestion takes place ; certain of the inner

cells secrete a digestive fluid, and the food acted upon by this fluid is absorbed by other endoderm cells lining the cavity. Thus the Hydra is a decided advance upon any protozoön, for it is many-celled, and among its cells some are utilized for specialized purposes ; it also has a distinct cavity in which digestion takes place.

Right here is the proper place to call attention to the Sponges, which, contrary to the uneducated popular idea, are animals, not plants. The "sponge" of commerce is the porous skeleton of a marine animal. The Hydra, we have just seen, has a simple tubular body, but the Sponges possess a system of branching tubes with external openings, some very minute, others more conspicuous. Water containing food-stuff flows into the tubes through the small openings, and passes out by the larger ones. There is thus a continuous circulation of water through the tube-system of the animal, and the circulation is effected by means of flagella, or tiny whip-like threads of protoplasm. The Sponge has an outer cell-layer covering a jelly-like substance containing "spicules" of lime or silica. The spicules are variously shaped, and are interesting microscopic objects ; they have forms suggesting axes, needles, anchors, crosses, etc., and they are arranged in the jelly-like substance so as to form a skeleton. There are, however, some Sponges in which spicules do not occur ; their place is taken by material termed "spongin." On the inside of the Sponge is a further layer of flagellated cells, which seize food from the circulating water, and thus do their part in the nourishment of the whole animal.

The uninitiated reader will, naturally, think of the sea as the home of Sponges, and may be surprised to learn that there are two freshwater Sponges to be found in Britain. One is the River Sponge (*Spongilla fluviatilis*) and the other the Lake Sponge (*Spongilla lacustis*), of which specimens may be found in ponds, reservoirs, and lakes. *S. lacustis* is usually dark-green in colour, and commonly attaches itself to timberwork, occurring in oval or roundish masses. Sponges increase by forming buds that become detached from the parent and establish new colonies ; and also by the formation of what may be called eggs—a process that our limited space will not allow us to discuss.

As we might naturally expect, the great division of the Animal Kingdom, called "Vermes," or Worms, is represented among the denizens of the pond. The Planarian Worms are among the lowest of this division. Some of them are very small, but whether microscopic in size, or relatively large, so as to be seen by the naked eye, they are all flattened animals which crawl, slug-fashion, over weeds and stones, or cling to mud. The largest freshwater species does not attain an inch in length. They can reproduce lost parts of their bodies, and if one is cut into two halves, each half can become a complete individual. They vary in colour. The White Planarian (*Planaria lactea*) is probably our largest species ; we also have species which are, respectively, brown, grey, and black, the last-named being common.

The Nematoids, or Threadworms, are also repre-

sented in the pond. The majority of these worms are parasitic, infesting the internal organs of animals, and even man is not free from the ravages of some of them; but there are species which live a more dignified and useful life by consuming decaying animal and vegetable matter. The so-called vinegar "eels," and the "eels" which appear in sour paste, are Nematoids. In examining mud and vegetation from ponds and pools, we are almost sure to find specimens of these animals, and when we place them in water we may see them swim in an eel-like fashion. Many of them are quite microscopic in size. Some Nematoids have great vitality; if taken out of water and allowed to dry up they do not die for a long time; if placed in moisture, even after being dry for weeks, they become active and behave as if nothing untoward had happened.

Mention must also be made of *Tubifex rivulorum*, the Red River or Summer Worm, which is an inch or more in length, and lives in the mud of ponds and ditches. It is sometimes present in such enormous quantities as to cause red patches to appear in the mud. These worms are to be seen in spring and summer, with their head ends in the mud and their tails exposed in the water. If disturbed they suddenly disappear into their burrows. The skin of this worm is transparent, so when we examine a specimen with a pocket-lens, or low power of the microscope, we can see all its internal organs quite clearly. It is the blood of *Tubifex* which gives it a red appearance.

The Common Horse-leech (*Hæmopsis sanguisuga*),

although a blood-sucking worm, does not batten upon horses, as its name seems to imply; it may occasionally relieve a frog of some blood, but it has a preference for the blood of worms, snails, and larvæ of various kinds. Having small teeth it cannot wound thick-skinned animals; it can deal only with soft bodies. This animal is to be found in ponds and lakes; it is about 4 inches long and half an inch broad; the tail end is thicker than the mouth end; in colour it is greenish-black above and yellow-green beneath. It is, also, a graceful swimmer, and when swimming its body is somewhat flattened, and it progresses through the water by a pretty undulatory motion. Other kinds of Leeches are to be found in British ponds, but we must pass them over with bare mention; there is one, the Eight-eyed Leech (*Nephelis octoculata*), which is not a blood-sucker; it swallows its prey; it is between 1 inch and 2 inches long, reddish-brown in colour, frequently spotted with yellow; and there are other much smaller kinds which creep about among vegetation and do not swim.

If we are to do anything like justice to the pond and its inhabitants, we must give a little attention to another class of microscopic animals, the Rotifers, or "Wheel Animalculæ," which may be regarded as a peculiar and well-marked group of the division Vermes. Early observers jumped to the conclusion that these animals possess organs which rotate like tiny wheels at their anterior extremities, and, hence, called them "wheel-bearers," and this ancient notion is indicated in the

term "Rotifer." The wheel-like motion, however, is apparent, not real; and the appearance is due to expanded discs fringed with cilia that are in continual motion when the animals are feeding or swimming. The action of these fine hairs creates a vortex, in the current of which food-stuff is carried to the mouth. Owing to the transparency of the bodies of these animals it is possible to see the internal organs in operation. Each animal possesses an alimentary canal terminating in an anus, and particularly noticeable in this canal is an organ called the "mastax," composed of teeth which work against each other in preparing food for digestion: it is most interesting to watch the mastax in operation, and it may be mentioned that the possession of this peculiar organ marks off Rotifers from all other microscopic animals. The posterior end of a Rotifer is produced into a projection called the "foot," by which the creature can attach itself to any suitable foothold.

There are numerous species of Rotifers, most of them frequenting fresh water; very few are marine. They have been grouped in four classes—the Rhizota, the Bdelloida, the Ploima, and the Scirtopoda. In the Rhizota (rooted) the foot cannot be drawn back into the body; it is used as a permanent means of attachment, and the mature animal lives a sedentary life in a tube which it secretes or builds. The Bdelloida (leech-like) creep like a "looper" caterpillar or a leech. The foot is used as a sucker, and objects can be grasped, in creeping, by an adhesive disc at the mouth end.

The Ploima (sea-worthy) are free-swimmers, but they have forked feet by which they occasionally attach themselves to an object. The Scirtopoda (skippers) are furnished with hollow, movable projections, like limbs, by means of which they skip or leap.

The Rhizota include some of the larger Rotifers, and by no means the least interesting species. The "Crown Animalcule" (*Stephanoceros Eichornii*) is a glorious creature. Being upwards of a fifteenth of an inch in length it can be seen with the naked eye, but, of course, we must use the microscope if we wish to examine it in detail. The adult animal is permanently fixed by its foot to some plant, such as the Water Milfoil, or perhaps on a rootlet of a Willow that has made its way into the water ; it surrounds itself with a sheath or gelatinous envelope, an almost cylindrical tube of jelly, secreted by itself, and into which it can retract when alarmed or otherwise necessary. When the animal is fully expanded and engaged in food-getting, the upper part of the body is protruded from the tube and is seen to be crowned with five curved arms, or processes, each one being furnished with long cilia, which, in action, produce a wave-like motion and a current for the capture of prey.

The "Beautiful Floscule" (*Floscularia cornuta*), see Fig. 24, another Rhizote, well deserves its popular name. It secretes an exceedingly delicate, transparent tube for protective purposes. It is not so large as *Stephanoceros*, and the lobes of the upper part of the body are decidedly different ; they are short and blunt,

Photo, J. Holmes

Water-Spider descending to nest with air-bubble (enlarged)

but armed with very long clustered cilia. When the Floscule retracts into its sheaf these cilia are thrown upwards and form a pencil.

FIG. 24.—ROTIFERS : *FLOSCULARIA.*

Melicerta ringens, the Brick-building Rotifer, is one of the most marvellous of the Rhizota. This animal settles on the leaf or stem of some pond plant, and there erects its permanent home. It makes very tiny round pellets, which it lays around itself in a small circle. Pellet after pellet is made, laid, and cemented to the others, until a tower-like tube is built. In this tube the *Melicerta* resides, like a king in his stronghold ; when in repose, or alarmed, the animal contracts into the space within the tube, but when feeding it protrudes its body, which opens out about the mouth like the petals of a flower. Each petal-like process is fringed with cilia, which move and create a vortex after the approved Rotifer fashion. This animal is not more than a fifteenth of an inch in length when fully extended ; its tiny tube is about half that measure in height.

Of the Bdelloida, the Common Rotifer (*Rotifer vulgaris*) is an excellent type. Fig. 25 gives a good idea of its appearances under the microscope. The foot is telescopic, and this may be shortened or lengthened at will ; as the drawing shows, there are two discs fringed with cilia. When the animal is at rest, the feet

and discs are retracted, and an almost spherical form is assumed. It is highly amusing to watch this creature "looping" its way over vegetation, and occasionally swimming with fully-extended body and active cilia. *R. vulgaris* is exceedingly common, and may be looked for in most moist situations ; it is found in ponds and puddles, among mosses, and even in roof-gutters ; the length, in full extension, is one-fiftieth of an inch.

FIG. 25.—*ROTIFER VULGARIS.*

Many species of Bdelloida live among the leaves and roots of mosses, and, like other animals already alluded to, can resist times of intense drought without loss of vitality.

The Ploima are well represented by the Pitcher Rotifers, which belong to the genus *Brachionus.* The animals of this genus are protected by a transparent "lorica," or shield, a sort of close-fitting coat of mail surrounding the body, but open fore and aft, and notched at the top. The broad, somewhat pitcher-like lorica accounts for the common name. The foot is a strong, muscular appendage, capable of being retracted into the lorica. Females are frequently seen carrying a number of eggs attached to the hinder part of the body ; I have seen half a dozen females temporarily anchored to the carapace of an active Water-flea, each loaded with eggs, yet not one

of them was more than a seventy-fifth of an inch long!

As far as I can ascertain there are only two species of the class Scirtopoda, one of which is the very small *Pedalion mirum*, recognized by its curious limbs and jumping habit; after jumping it glides for a short space, then jumps again.

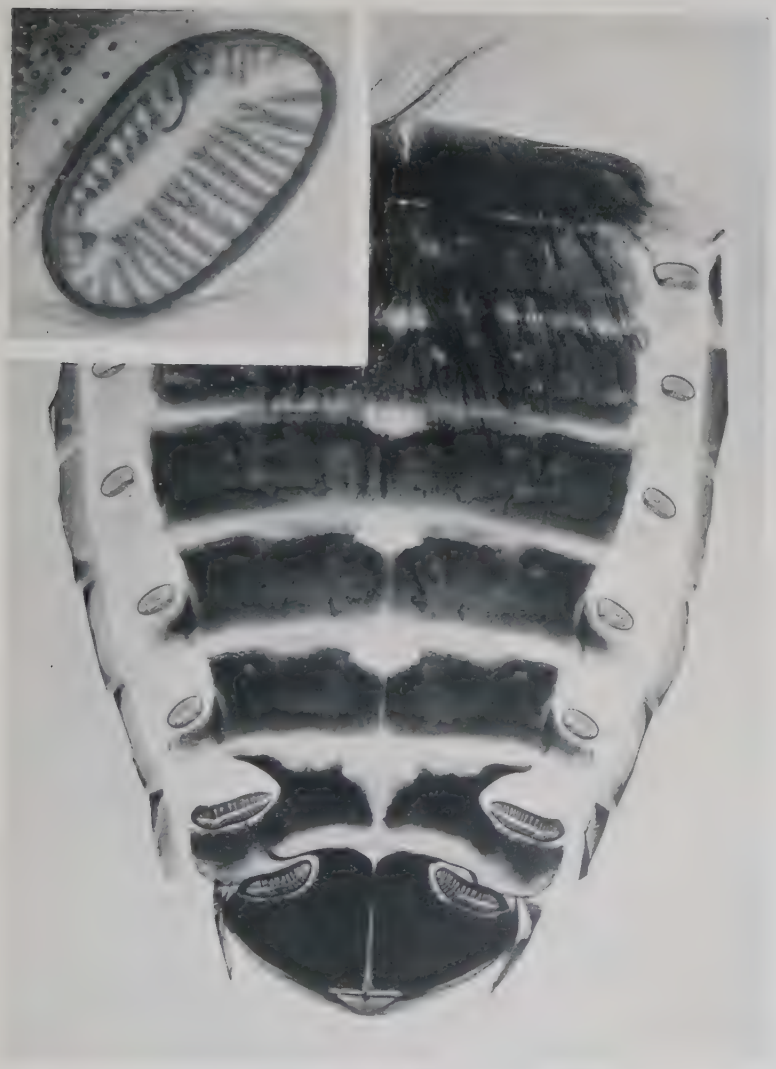
Although possibly not following the order of a strictly scientific classification of animals, it is convenient here to mention the Polyzoa (Greek, *poly*, many; and *zōon*, animal), or, as they are sometimes called, the Bryozoa (moss-animals). They, also, are tiny creatures; they live in colonies, the members of which spring from a common base, which may be branched like a tree, leaf-like, disc-shaped, and may form a sort of crust on the rock or vegetation to which it is attached. Most species are marine, but there are some freshwater forms which are to be found in ponds attached to floating plants, roots of trees that are exposed in the water, or other submerged objects. Each animal of the colony possesses an alimentary canal, with gullet, stomach, intestine, and vent, as well as a nerve ganglion. In the freshwater species, each individual lives in a secreted transparent, membranous sac or tube, into which the body can be entirely retracted; but when the animal is extended, the mouth appears out of the sac, and is seen to be surrounded by a beautiful U-shaped crown of tentacles, fringed with cilia, and termed the "lophophore." It is an inspiration to watch a colony of polyzoöns, under a low power of the microscope, as

they gracefully protrude and unfold their tentacles, and suddenly retract them into their protective sheaths when they are alarmed.

Plumatella is one of the commoner freshwater Polyzoa which may be looked for in ponds, but not always with the certainty of finding it. Where it does occur it is usually common, and its colonies may radiate over an area of several square inches. These colonies branch like a tree. *Plumatella* is a genus including several species, *P. repens* being the best known. The colonies of another genus, *Alcyonella*, form sponge-like masses.

Cristatella mucedo forms colonies which, when the tentacles of the animals are expanded, and the colonies are full grown, resemble hairy caterpillars. In its early stage (Plate VII.) each colony is spherical in form, but as it grows it becomes longer without increasing in breadth, until it attains a length of 2 to 4 inches, the width being about a quarter of an inch. Perhaps, with its rounded upper surface and flattened under surface, it may be wisely likened to a slug covered with tufts. This species is remarkable for its liking for sunlight, usually abhorrent to polyzoöns, and also for the fact that the entire colony, in slug-like fashion, can change its ground.

Lophopus crystallinus, the Plumed Polyp (see Plate VII.), is an exceedingly beautiful polyzoön. The colony, composed of about a dozen animals, is invested by a transparent, jelly-like membrane, which has been likened to a cup. Baker, in his "Employment for the Microscope," says that this membrane "out of the water has



Upper surface of abdomen of Water-Beetle (*D. Marginalis*), with wings removed and magnified × 6 to show rows of "spiracles" or breathing pores. Inset, a single spiracle, × 60

no determined form, appearing like a lump of slime, but when the animals are expanded therein it resembles nearly the figure of a bell with the mouth upwards, and is usually about the length of half an inch, and a quarter of an inch in diameter." In this species, which is comparatively large, we can easily watch the development of the "statoblasts"; these are resting-buds, which start as colourless swellings of the body, but eventually become detached in the form of round masses, dark brown in the centres, and yellow on their margins. These buds are enclosed in horn-like cases; they remain in the body until the colony perishes in the autumn, when they are set free. They remain undeveloped during the winter, but with the advent of genial conditions, say in spring, the cases open like cockle-shells, and liberate young individuals, which eventually attach themselves to a foothold, and grow by sending out ordinary buds. The statoblast is evidently a means of perpetuating a race which cannot thrive in ordinary activity during the cold of winter.

CHAPTER IV

CRUSTACEANS, SPIDERS, AND MITES

HIGHER in the scale of animal life than any creatures we have yet discussed are the Arthropoda (Greek, *arthron*, a joint; *podos*, a foot). This subdivision of the animal kingdom includes Crabs, Lobsters, Spiders, Insects, Scorpions, Centipedes, etc. All these animals

have bodies divided into a number of segments, at least some of which bear pairs of limbs, and the limbs are usually jointed ; they also possess elaborate digestive, circulatory, and nervous systems. There are four great classes of the Arthropoda—the Crustacea, the Myriapoda, the Insecta, and the Arachnida. In this chapter we shall confine our attention to some representatives of the Crustacea and the Arachnida, of course only such as are to be found in a pond.

The Crustacea (Latin, *crusta*, a rind) are protected with a carapace, or shield. They are more numerous in the sea than in fresh water: Crabs, Lobsters, and Shrimps belong to this class. The largest freshwater example is the Crayfish, or "Freshwater Lobster," but as this is not found in ponds we shall not describe it.

The Crustacea of the pond do not attain any great size ; some of them are very small. One of the larger sort is the Freshwater Shrimp (*Gammarus pulex*), and this is not more than half an inch long ; it is closely related to the little Sandhoppers which are so numerous on the seashore. This animal is, perhaps, more common in ditches and streams than in ponds ; I have found it in considerable numbers in muddy pools. It has a flattened body, reddish in colour, bent inwards in such a way as to suggest a humped back ; it swims upon its side with a lively, jerky motion. The female carries its eggs in a brood pouch under the body, and when the young are hatched they follow the parent for a time. As the youngsters grow they get too big for their shells, which are horny ; they get over the "tight-

PLATE 12

(1)

(2)

(3)

(4)

(1) Tench (2) Perch (3) Roach (4) Pike

lacing" trouble by casting their shells, and secreting bigger ones, an operation that is often repeated. As this Shrimp feeds upon decaying vegetable and animal matter, it may be regarded as a natural scavenger.

Another Crustacean of the pond, comparable to the aforementioned in length, is quite common—this is the Water-louse (*Asellus aquaticus*). Its body is composed of nine segments, one of which is the head, the last one the abdomen, while the seven segments between head and abdomen constitute the thorax. Each segment of the thorax bears a pair of legs. The head is furnished with long antennæ, or "feelers." This animal may be easily known by its likeness to the Wood-louse, "slater," or "garden-bug," that familiar grey creature which we find under the bark of decaying trees, under stones and elsewhere. The female Water-louse is somewhat smaller than the male.

Among the smaller Crustaceans to be found in the pond the best known and most commonly described is the Water-flea, of which there are several species. It is, indeed, seldom that we dip a bottle into the water without capturing some of these lively animals. Needless to say they are not fleas, but the manner in which they jerk their way about the water is suggestive of the progress of a flea—hence the common name which has been given to them. They make excellent objects for the microscope, for, being transparent, with the aid of that instrument we can observe every detail of their structure.

Daphina pulex, the common Water-flea, is something over a sixteenth of an inch long, and about half as

broad. The male is much smaller than the female, and is not common. The general appearance under magnification is indicated by Fig. 26. The body is protected by a transparent carapace, or shell, through which we can discern not only the five pairs of legs, but also the digestive organs, the pulsating heart, and, in a female, the ovary, and a space between the back of the body and the shell in which eggs are carried until they are mature. The delicate shell consists of two valves, joined above the back, but open and allowing free movement of the legs on the under side of the body. The head is small, furnished with one pair of very small antennæ, and another larger, branched and feathered, pair, which are flourished by the animal, and used in swimming. The eye is multiple, consisting of about twenty lenses. The shell covers the head, and is prolonged into a beak ; it seems to be harder in the head region than about the rest of the body ; we have an idea of its protective value when we distinctly hear Water-fleas in a glass tube knocking their heads against its walls without suffering any dire harm. The attachment of the body to the shell is very slight, and the shell is regularly moulted, both by growing individuals and those which have arrived at full size.

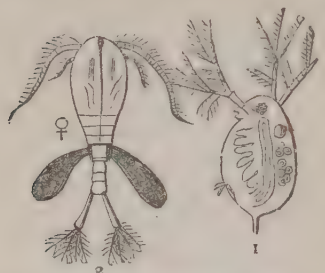


FIG. 26.—FRESHWATER CRUSTACEANS.
1, Water-flea ; 2, female Cyclops with egg-sacs.

As common in the pond, if not more common than Water-fleas, is the tiny Crustacean *Cyclops quadricornis* (Fig. 26), usually called *Cyclops*. It has a single eye in the middle of its head, and is named after the one-eyed giants of the Greek myth. The body is pear-shaped and segmented. The head is furnished with a pair of long antennæ, each one having twenty-six joints, and each joint bearing a bristle. The last segment of the body is divided into two lobes, each bearing a tuft of transparent bristles. There are five pairs of feet, four of which are actively used as oars in swimming. The females largely outnumber the males, and are frequently seen carrying a pair of external egg-sacs, full of eggs, attached one sac on either side of the hinder part of the body. Like the Water-flea, which it about equals in length, though not in breadth, *Cyclops* moults its shell from time to time: it is exceedingly prolific.

Canthocamptus minutus, sometimes called the Little Cyclops, or Vaulter, has a body which tapers more gradually than that of *Cyclops*; besides, it has much shorter antennæ, which, in the female, have nine joints, in the male seven. The female carries but one egg pouch, whereas *Cyclops* carries a pair.

The genus *Chydorus* embraces two species of microscopic Crustaceans, bearing a distant resemblance to Water-fleas, but differing from them in important respects. *Chydorus sphæricus* has an olive-green shell, which is round, smooth on its surface, and slightly fringed on the lower edges. The beak is long, pointed and curved inwards, or crescent-shaped. The antennæ

are short, and "its motion through the water is more like rolling than swimming." Pritchard says: "The young play near their parents, and at the approach of danger swim for protection within the shell of the mother." *C. globosus* closely resembles *C. sphæricus*, but its shell is even more round, and several times larger, while the beak is very long.

One more Crustacean—*Cypris*, the name given to a genus containing fifteen species which we shall not enumerate. *Cypris* differs from *Daphnia*, *Cyclops*, or *Chydorus* in several details. The shell is of two valves, connected at one point at the back by a ligament, and the valves can be opened or closed as desired; it has been likened to a minute mussel shell. The shape of the shell is nearly oval, and there are two pairs of antennæ, one being long and furnished with a pencil of hairs, the other short and foot-like. There are two pairs of feet. The eye is single. The various species are all very active, hardly ever resting; swimming by means of their antennæ, or walking upon plants or other objects in the water.

Turning now to the Arachnida, which are air-breathing animals, possessing four pairs of walking legs and no true antennæ, and include the Spiders, Mites, and Scorpions, we give first place to the wonderful Water-spider (*Argyroneta aquatica*). This animal (see Plate X.) has eight eyes; the fore part of the body is protected by a slightly hairy, reddish-brown shield; the abdomen is very hairy, olive in colour, and pitted with four small pits. The hairs on the under side of the body

are remarkably long; the legs are thick and reddish-brown. The male is larger than the female, which is about half an inch in length. A mere museum specimen of this Spider gives but a poor notion of its appearance in life; we can realize its characters and habits only by observing it under natural conditions. We need to see it dive into the water with a load of air, which it entangles in the fine downy hairs of the abdomen; then it appears like a globule of quick-silver. We need, also, to see the air deposited in a wonderfully constructed silken bell carefully moored, under water, to submerged plants by the finest of silken cables. The Water-spider is an air-breather, and is quite at home on land, but it has taken to the water probably because it provides plenty of prey. The silken bell referred to is its home in the water, and it is used as the repository for the batch of eggs, each carefully enclosed in a silken cocoon. It is also a place of rest and observation from which the Spider can rush out to secure prey. As the animal must have air, which it cannot get in water, it carries a supply from the surface, and may be seen diving with load after load and depositing each load into the bell until it has been stocked. With such an air supply, the Spider can stay under water for long periods. It sometimes hunts ashore, but always carries prey to its home in the water before devouring it. When the young emerge from the eggs, each one is surrounded with a globule of air, and they live in the water like the adults.

One of the Wolf-spiders (*Lycosa piratica*) hunts on

the surface of the water, and often dives when danger threatens, and, as air is entangled by the hairs on the abdomen, it can remain in water for some time.

The Mites belong to the same class as the Spiders, but to a different order—the Acarina (Greek, *akares*, a morsel) ; the familiar Cheese-mite is a good example, as also is the Red-mite, erroneously called a Spider, which is said to cause such great damage to hot-house plants. We find in the pond many species of Water-mites, of the order Hydrachnidæ, which are sometimes mistaken for small Water-spiders. These Mites are less than an eighth of an inch in length, so they can be seen with the naked eye ; they are of various colours when fully developed, bright red, spotted with black or brown, being the most general. They are active little animals, some of them swimming freely, while others creep over weeds. The Hydrachnidæ develop from eggs, from which six-legged larval forms emerge ; these swim freely for a time, but eventually attach themselves to other animals, notably insects, upon which they live as parasites. When they are fully established upon their hosts they lose their legs. After a time another change takes place ; they become free-swimming nymphs, with eight legs ; they are then larger than in the larval form ; ultimately they pass from the nymph stage to the adult condition, when they are fully coloured and have eight legs. Some are parasitic even in the adult stage.

The Tardigrades, or Water-bears, are microscopic "wee beasties" related to the Mites. They are found

crawling over water plants, in damp moss, and even among moist dirt in gutters of roofs. Their oblong bodies possess four pairs of legs furnished with claws; as they grub about among weeds in quest of food they look, when magnified, remarkably like bear-cubs.

CHAPTER V

SOME INSECTS OF THE POND

Were we to deal anything like fully with the insect life of the pond we should have to fill the pages of a large volume; all we can do in the space at our command here is to present a rapid sketch of the commoner and more outstanding insects that are associated with the pond. Assuming that the reader is sufficiently versed in Natural History to be able to recognize an insect when he sees one, we shall omit any preliminary reference to insect anatomy and classification, and plunge right into our subject, commencing with three common Beetles which the observer cannot fail to identify when he sees them.

When we see in the pond, and perhaps capture for closer examination, a large Beetle, fully an inch in length, of elongated oval shape, rounded above and angulated beneath, in colour olive-brown with a yellow margin, we may rest assured that it is *Dytiscus marginalis*, the Great Brown Water-beetle (Plate IV.). If our specimen has furrowed wing-cases it is a female, but if the wing-

cases are smooth, and if, also, there is an enlargement of three joints of the fore-leg, forming a powerful suctorial disc with which the animal can grasp objects firmly, the specimen is a male. The female does not have this remarkable development of the fore-leg. This Beetle has been well called the "ogre" of the pond; it has a voracious appetite and a rapacious disposition; it will attack anything from a fish to a water-flea, and it seems to kill, not merely for food, but for the sheer delight of killing. I have seen a dozen of these Beetles attack and altogether discomfit a snake that was introduced into the tank in which they were kept for observation. If it is desired to keep gold-fish in a garden pond, *D. marginalis* must not bear them company; if he is permitted to do so, the fish will soon be destroyed. This Beetle is an air-breather, so must needs rise to the surface of the water for air supplies, which he stores in a chamber under his wings and between them and his back. The breathing apparatus (see Plate XI.) opens into this air space, in which a supply of air can be retained sufficient for prolonged stays beneath the surface of the water. This insect can fly, and frequently takes long flights in the gloaming. If a piece of water is not to its taste it will take wing and settle in another pool or pond. The female lays eggs in slits which she makes in aquatic plants; these eggs hatch in a couple of weeks or so, and the larvæ which emerge are even more voracious than their parents. They attain a length of about 2 inches when fully grown; they possess terrible jaws, which they use to murderous effect. So bold and wicked

Pied Wagtail

PLATE 13

are these larvæ that they have earned the name "Water Devils." Before the larva can become a perfect Beetle it has to pass through the pupa state. When the time arrives for this change, it stops feeding, makes its way to soft, moist earth near the margin of the water, and makes a cell, in which, in due course, it becomes a pupa. In summer it remains a pupa for about a couple of weeks. After that period of comparative rest, a full-fledged desperado forces his way out of the cell and continues, perhaps for some years, those deeds of derring-do that were began in his previous larval incarnation.

D. marginalis is one of the largest British Beetles, but it is outsized by the Great Water Beetle (*Hydrophilus piceus*), a picture of which is given on Plate IV. This insect is oval in form, and nearly 2 inches in length. It is an air-breather, and has means for storage of air while it is under water. It is not so powerful a swimmer as *Dytiscus*, nor is it so blood-thirsty. While it may occasionally feed on small water animals, it generally satisfies itself with vegetable food. The wing-cases are coloured olive-black. The insect will often leave the water at night, and indulge in a flying excursion. The female prepares a shining, silvery, waterproof cocoon for her eggs; this floats on the water, and is furnished with a mast-like projection for the admission of air.

The insects which we so frequently see in companies most actively engaged in describing circles with great rapidity on the surface of the water are Whirligig

Beetles (*Gyrinidæ*). If one makes a dash for them with a net they immediately make a quick dive, and generally elude capture by so doing. *Gyrinus natator* is a common species ; it is about a quarter of an inch long, oval in form, steel-blue above, bronze beneath, and has reddish-brown legs. When it dives, a globule of air, which shines like mercury, is seen attached to the end of the abdomen. It can fly quite easily, but has to get a " start " from the vantage-point of a plant or some object rising out of the water ; it does not seem to be able to fly directly from the surface of the water.

Beetles belong to the order Coleoptera (Greek, sheath-wings) ; they have two pairs of wings, the outer pair being horny, and acting as covers to the flying wings when they are not in use. The insects of the order Neuroptera are different ; they have four wings, all used in flight, which are membranous, and marked with many nervures. The Dragon-flies are of this order. We have nearly fifty British species. He would indeed be a tyro in Nature-study who did not know a Dragon-fly on sight. Although the perfect Dragon-fly is a creature of the air, there winging a rapid course in quest of insect victims, the early stages of its career are aquatic ; indeed, the greater part of its life is spent in water. The method of egg deposition seems to vary with different species. In one instance (*Diplax*) the female is said to lay her eggs in a kind of chain ; some species cut slits in soft aquatic plants, and insert an egg in each slit ; others seem to drop their eggs, one at a time or in groups, into the water over which

they hover. All lay either in or very near water, so that the young larvæ, when they emerge, may be in the element for which they are peculiarly adapted.

The life-story of one species of Dragon-fly (see Plate V.) is practically that of all. The larva is vastly different from the gorgeous sunshine-loving adult; it is far from pretty; it is awkward in its movements, and its rapacity knows no bounds. By means of its six legs it can cling to aquatic plants, and crawl over them, or over mud, in quest of prey. It can, on occasion, shoot itself through the water, which is hardly a swim; but a larva may cling to a plant and remain almost motionless for hours. In such a state it is not very conspicuous, and unwary creatures discover it when it is too late. The almost hidden and seemingly inactive larva, when suitable animals swim into its near neighbourhood, exhibits a merciless alertness. If the approaching creature is desirable food, the larva will shoot out what is known as a "mask" (see Plate XIV.)—a jointed apparatus connected with the head, armed with a pair of claws. The claws grip the victim, and when it is secured it is dragged to the mouth, which is some distance behind the free, clawed, end of the mask, and there it is torn to pieces and dispatched. It is interesting to have Dragon-fly larvæ in an aquarium, and watch one stealthily approach a victim, suddenly shoot out its mask, grip the prey, and convey it to its mouth.

The larvæ consume almost any animal food; they will capture and eat snails, tadpoles, insects, small fishes,

and, if food is not plentiful otherwise, they will turn cannibal. The young larvæ grow apace, and the skin is changed many times. The aquatic life of a Dragon-fly may last for two or three seasons; part of that time it is a larva, and for the remainder it is a pupa. The pupal stage is indicated by the appearance of wing-cases; but the pupa is not inactive like that of a butterfly, it is even more hungry than it was in the larval state; it is still armed with the "mask," and is one of the most predaceous denizens of the pond. But the time approaches for the grand change; the pupa creeps along the stem of a plant out of the water into the air; it clings firmly to its foothold, and, after some hours, the perfect insect emerges from the pupal skin, and is free to enjoy the air and sunshine, and to hawk for insect food for, perhaps, a month or six weeks, during which period the males and females will court and marry with a view to the multiplication of the species. The Dragon-fly is popularly supposed to "sting," but it does not do so.

The May-flies (*Ephemeridæ*) form a family of the Neuroptera; they are also called "Day-flies" as an indication of the brevity of their existence in the perfect state. Some emerge from the pupal condition after sunset, and perish before sunrise, so they exist only for a night; others live for a day or so. But if life is so brief in the perfect state, it is not so in the larval stages, for May-fly larvæ may exist for a year, or even three years; the term varies with the species. The adult female, during its brief life, lays eggs which sink into

the water, and stick to weeds or stones. The larvæ, which feed upon animals of the smaller kinds, change their skins to accommodate their growing bulk; they are long and flattened, furnished with a pair of antennæ, and have three feathery filaments, which look like tails, appended to the end of the abdomen. The six legs are flattened, and bear fringes of hairs. There are also six pairs of gills which are used in breathing.

Ephemera vulgata, the common May-fly (Plate VIII.), is a species very frequently found; its larva can walk or swim at will. The perfect insect emerges towards sunset about the end of May, when hundreds are to be seen in a group near some tree, dancing in the air. They are very fragile, the wings being particularly delicate; the fore-wings are much larger than the hind-wings, the antennæ are short, and attached to the last segment of the abdomen are two or three long hairs, or bristles, which are longer than the body. The fore-legs are long, and are so extended in flight as to be easily mistaken for antennæ. There are no means of eating or sucking, so that in the brief life of the perfect insect it enjoys no food; indeed, that short span is fully occupied with courtship and marriage.

Whether the Caddis-flies (Plate VIII.) ought to be classed as Neuroptera is a disputed point; but many naturalists settle the problem by denominating them "Trichoptera" (Greek, *trichos*, hair; *pteron*, wing), because their wings are clothed with hairs. Some of the species are so like moths in general appearance that they are often mistaken for them; but there is one simple

point by which they can be distinguished; their wings are clothed with hairs, often coloured and arrayed in a distinct colour scheme; but the wings of moths are furnished with tiny coloured scales. A pocket-lens reveals the distinction. Caddis-flies have two pairs of wings, the hinder pair being shorter, but often wider than the front pair; each wing displays a network of nervures. When the insect is resting, the hind-wings close like a fan and are entirely covered by the fore-wings. The mouth organs are undeveloped; so it is apparent that the insect does not feed.

But the Caddis-worm, or Caddis-larva, provides us with greater interest than the perfect insect. To quote from the old naturalist, Réaumur: "The body of these larvæ is lodged in a silken tube, to the outside of which are fastened fragments of different substances, selected for the purpose of strengthening and defending it. The sheaths may be quite irregular, rough and prickly, or smooth and symmetrical. When the old sheath becomes too narrow or too short, the larva makes a fresh one. . . . They clothe their tubes with very different materials. They make use of whole or nearly whole leaves, bits of leaves, or little sticks or straws. Others use seeds, roots, grains of sand and gravel, or the shells of water-snails and bivalves; in short, all the materials which can be found in water are employed by particular Caddis-worms." It should be added that it is more common for a larva to add to the wider end of its case and enlarge it than discard it in favour of a new one; the end which has become too small is cut off after the

enlargement has been effected. That the Caddis-larva makes and occupies such a tube in order to protect itself is obvious, and it sticks to its home with great tenacity. It is furnished at its hinder end with a pair of recurved hooks by which it holds on to the tube, and it is not easily dislodged. When the animal moves it carries its tube with it, only thrusting out sufficient of the fore part of its body to enable it to use its walking legs. If disturbed it immediately withdraws entirely into the tube. The larvæ of most species feed on vegetable matter. Before becoming perfect insects they pass through a pupal stage, just prior to which they cease feeding, attach their tubes to a plant or stone, or partially bury them in a vertical position in mud. In the former case both ends of the tube are closed with a web; in the latter, the end exposed to the water is so closed. There are nearly 160 species of British Caddis-flies.

We shall now consider briefly three species of Water-bugs, which belong to the tribe Hydrocorisa. Not the least interesting of the three is the Water-scorpion (*Nepa cinerea*), common in nearly all ponds. A grown larva is very similar to the adult insect, with the exception that the latter has wings and is larger. This bug attains a length of about an inch; it is elliptical when viewed from above, but flat and leaf-like when seen from the side. The colour is dark-brown. The fore-legs are prehensile—that is, they can grasp objects; they are furnished with claws which can fold inwards like the blades of a pocket-knife.

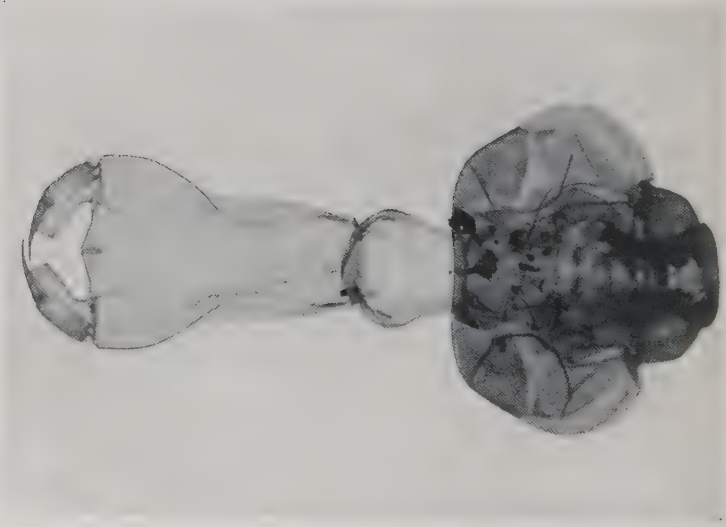
Needless to say, these are used for seizing prey. The victim is not eaten, but its juices are sucked by means of a beak or rostrum which is thrust into the body; this rostrum is strong enough to pierce the human skin. Water-scorpions possess four other legs, used in crawling or swimming. A slender breathing-tube proceeds from the tip of the abdomen, and when oxygen is required the insect secures it by rising in the water and pushing this tube into the air. This animal, when adult, can fly, but seldom does so. The oval eggs laid by the female have each seven bristles at one end, and these bristles form a cup for the reception of the next egg. Thus the eggs are laid in a chain. This insect, it will be noted, is aquatic in all stages; it is illustrated on Plate V.

The Water-boatman (*Notonecta glauca*), see Plate IV., is another Bug equally as common as the Water-scorpion. One can seldom pass a net through the water of a pond without catching a specimen. The body is about half an inch long, generally of a yellowish hue; it is furnished with six legs, the hindmost pair being specialized to act as oars with which the animal swims. It always swims upon its back, and looks pretty in water owing to air entangled about its body, giving it the appearance of an animated mass of quicksilver. Taken out of water, it turns back uppermost and jumps or hops about. The larva has no wings, but the adult possesses four, the front pair being partly horny, and the hinder pair membranous; it can fly well, and often leaves the water to do so. In capturing prey, it swims under its

PLATE 14

(1)

(2)



(1) Oar-leg of Water-Boatman. $\times 8$

(2) Head and "Mask" of Dragon-Fly larva. $\times 5\frac{1}{2}$

victim and seizes it with its fore-legs; like other bugs, it feeds by suction. Its sucking apparatus—the rostrum—is quite strong enough to inflict a painful wound on human flesh. The female *Notonecta*, in egg-laying, makes incisions in the stalks of submerged plants. One egg is placed in each incision, so that about a third of its length is exposed to the water. It is at the end of the egg thus exposed that the head of the embryo will appear. The Water-boatman is very buoyant, and rises to the surface without effort; on this account it is frequently to be seen at the surface. When it goes below it has to swim, and in order to stay below it must needs cling to weeds or other submerged objects.

The Water-bugs of the genus *Corixa* are less buoyant than *Notonecta*, and spend most of their time at the bottom of the pond; they resemble Water-boatmen in some respects. They possess oar-legs, but they swim back uppermost, and their fore-legs are not so prehensile as those of *Notonecta*. They do not swim so powerfully, nor are they as rapacious as their distant cousins. Looking into a pond, we may see them swim rapidly to the surface, pause for an instant, then speedily descend to the bottom. They rise for a supply of air, and then return to the position in which they can most comfortably and effectively search for prey. Perhaps the commonest, and certainly the largest, species is *Corixa Geoffroyi*. It is half an inch in length, dark brown, with minute yellow spots on the back, the thorax being striped with yellow and black lines. The legs are yellow and fringed with hairs.

The order Diptera (Greek, "two-winged") includes a multitude of flies, some of which spend their larval existence in ponds. Our rapidly diminishing space admits of the mention of only one—the Common Gnat. Everybody who roams in the vicinity of moist ground on quiet summer evenings is acquainted with the Gnat; it is the tiny fly which buzzes about one's ears and then inflicts an irritating "bite." The female is the culprit, and, if one may be guilty of a "bull," the bite is not a bite. The irritation is caused by the piercing of the skin with a lancet, with which the female is furnished, and the sucking of blood for food; no irritating poison is injected in the process. The male Gnats possess much-plumed antennæ; those of the females are also plumed, but not to the same extent. The long, narrow, curved wings are clothed with tiny scales. The legs are very slender and long. The female, holding on to some floating object, lays some 200 or 300 eggs, which she glues together in such a manner that they form an "egg-boat," or raft. This little boat of eggs floats freely on the surface of the water, and is practically unsinkable. In a few days the eggs hatch; a sort of door opens on the under end of each egg, a larva enters the water, and the door closes behind it. The larva now spends a free life in the water—it is a remarkable little creature, with a large head and chest, and an elongated body. It possesses no limbs, but swims by wriggling. Near the end of the body is a curious breathing tube, with bristles about its orifice; this tube is protruded above the surface of the water, with the bristles spread

out like a star. They allow air to be absorbed, but prevent the tube from being choked with water. While air is being taken in, the larva is suspended head downwards from the surface. The growing larva changes its skin several times, then becomes a pupa with what might be taken for an enormous head, but which is really a skin enclosing wings, head, thorax, and legs of the developing Gnat. The pupa suspends itself from the surface head uppermost, and is furnished with two curved breathing tubes which protrude into the air. The pupa does not feed, but remains quiescent at the surface, and is in a position convenient for the emergence of the perfect insect into the air without being wetted. The pupa skin is used as a raft upon which the insect rests until its wings are expanded and all is ready for a short and merry aerial existence. In Britain we have several species of Gnats, the Common Gnat (*Culex pipiens*) being, perhaps, the most abundant.

Of the scale-winged insects, order Lepidoptera, there are five species of British Moths whose larvæ are aquatic; four are popularly known as "China Marks" (see Plate VIII.). The eggs are laid on water-plants, and when the larvæ emerge they eat into the plants and soon construct a case, or house, of pieces of leaves stuck together. The cases are enlarged as the larvæ increase in size, and the pupa state is passed in the larval cases. The caterpillars feed on plants. The Beautiful China Mark (*Hydrocampa stagnata*) has a wing expanse of about three-quarters of an inch. The wings are shining white, with brownish-yellow markings. The larva is yellow,

has a brown head, and feeds on bur-reed and other water plants. The Brown China Mark (*Hydrocampa nymphæata*) has white wings, marked with yellow and shades of brown ; they extend, in expanse, to an inch or slightly more. The perfect insect appears in summer. The larva is yellowish-brown, with a darker line along the back. It feeds on leaves of pond-weed and water-lilies. *Cataclysta lemnata*, the Small China Mark ; *Paraponyx stratiota*, the Ringed China Mark ; and *Acentropus niveus*, the False Caddis-fly, are the remaining Moths which have aquatic larvæ. The last-named bears a very close resemblance to a Caddis-fly, and was until comparatively recent times classed among the Trichoptera. The wings of the female are rudimentary, those of the male expand to about half an inch ; they are white, bear no markings, but there is a brownish tinge on the fore-wings. The female is to be discovered among pond-weed ; it lays its eggs under water. The larva is green.

CHAPTER VI

SOME MOLLUSCS OF THE POND

Molluscs (Latin, *mollis*, soft) are soft-bodied animals without internal skeletons, but possessing a well-developed digestive canal, a heart, and nervous system. About thirty species may be looked for in ponds, and these are all furnished with shells formed of carbonate

of lime secreted by the "mantle," a tough, thick, but soft skin with which the body is clothed. The Molluscs of the pond are of two classes, Lamellibranchs and Gasteropods. The Lamellibranchs (plate-gills) breathe by gills in the form of thin membranous plates, hence their name; they are without heads, and secrete shells consisting of two valves, and so are often referred to as "bivalves." The Gasteropods (belly-foot) possess heads, and crawl or swim by means of the flat muscular under-surface of their bodies. As their shells are of one valve, they are commonly termed "univalves." The Mussel is a good example of the first class, and the Common Garden Snail of the second. The two valves of the shell of a bivalve are hinged by means of a ligament. But we shall not concern ourselves here with anatomical details; the space that we can spare will be devoted to a description of the external characters of the commoner pond Molluscs, so that the reader may be able to identify them when he finds them.

Sphærium corneum, the "Horny Cyclas," is a common pond bivalve. The name *Sphærium* indicates that the shell is almost spherical. The two valves are equal in size and form; the colour is brownish, or yellowish-brown. The hinge, or ligament, is small, and does not appear on the outside. The valves are marked with fine striations. The length approximates half an inch; breadth, five-sixteenths of an inch; thickness, quarter of an inch.

Pisidium amnicum, which does not seem to have a popular name, is a small bivalve with a triangular

shell, grooved concentrically. The colour is greyish or brownish. The ligament is short, and appears externally. Length, about one-third of an inch; width, quarter of an inch; thickness, about one-twelfth of an inch. Another species of the same genus, *P. fontinale*, is very common; its finely striated, greyish, triangular shell is barely more than one-sixth of an inch in length. *P. roseum* and *P. nitidum* are even smaller; they are respectively one-twelfth and one-tenth of an inch long. Their shells are very thin—that of *nitidum* being nearly globular, while that of *roseum* is oblong.

The freshwater Mussels are classed in the family Unionidæ (*unio*, a pearl), a term indicating their habit of forming pearly matter or "nacre" on the inside of their shells. The family is divided into two genera, *Unio* and *Anodonta*.

The Swollen Freshwater, or "Duck," Mussel (*Unio tumidus*) is a fine, handsome bivalve. The shell appears swollen, hence the name *tumidus*; it is ovate, oblong, solid, and brown in colour. It attains a length of about 3 inches, and is about half an inch in thickness. *Unio pictorum*, the "Painter's Mussel," has a slimmer appearance than *U. tumidus*; it is not so thick. The shell is oblong, wedge-shaped, yellowish-brown, or greenish-yellow, marked with darker bands. The length may be from 2 to 3 inches. These two species are not recorded for Scotland or Ireland.

The *Anodonta* have thinner shells than is the case with *Unio*, and the hinges joining them have no teeth. The "Swan Mussel" (*Anodonta cygnea*) is the better

known of the two British species, and it is more widely distributed in Britain than the two Mussels already mentioned. The greyish body of the animal is somewhat tinged with red or yellow, and it has a yellow "foot." The large, oval shell is dull green, or rusty brown. Perhaps it averages 5 inches in length, but specimens 8 or 9 inches long are sometimes found.

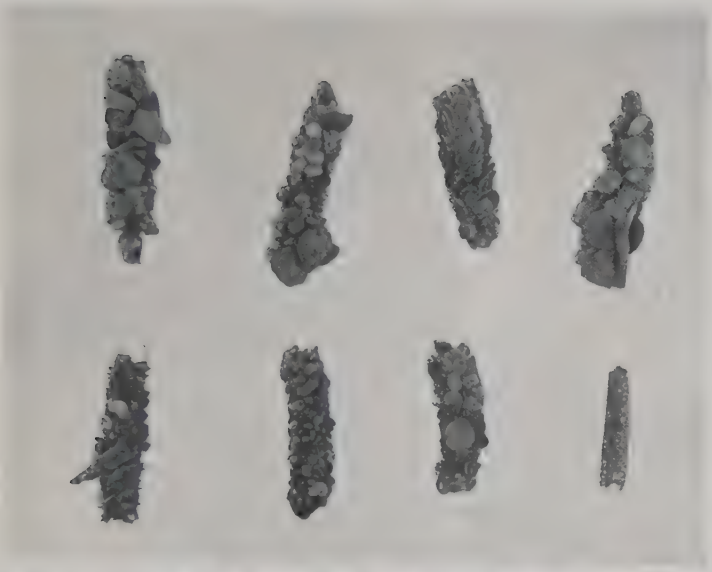
The Gasteropod or univalve molluscs which inhabit freshwater are popularly called "Freshwater Snails." A number of species may be looked for in the pond, crawling over submerged plants, or attached to the undersides of any floating objects. They all have distinct heads, furnished, in some species, with two tentacles, in others with four. They also have eyes, sometimes located at the ends of tentacles, sometimes at their base.

Paludina vivipara, the "Freshwater Winkle" (see Plate IX.), found in some English waters, but not recorded for Ireland or Scotland, although so limited in its distribution, is worthy of description. The general shape of the shell is that of a cone from an inch to one and a half inches in length; its mouth is oval. The whorls of the shells are bulged—that is, convex; the big body-whorl is ornamented with three brown bands, the remaining whorls with two. The animal, which has a blackish body spotted with yellow, and eyes situated at the base of its tentacles, possesses a horny "operculum," a plate with which it can close the mouth of its shell: thus it can withdraw into its chamber, and close its door against the outside world. The young are hatched, from eggs, *inside* the parent's body.

The univalves of the genus *Planorbis*, of which there are about a dozen British species, have flat, spiral shells, and the animals possess two long, slender tentacles. I have heard some of the larger kinds called "Trumpet Snails," but the largest of them all, *P. corneus*, is popularly known as the "Ramshorn Snail" (see Plate IX.). Unfortunately, this handsome species is local in its distribution; it has not been recorded in Scotland or Ireland. The swollen reddish-brown shell, which has five or six whorls in its spiral, may grow to an inch in diameter; it is usually dirty and overgrown with algæ when found in nature, but when we clean it we find it is glossy. The shell of another species, *P. vortex*, is about three-eighths of an inch in diameter; it has from six to eight whorls, the outer one being keeled. It is very flat, brownish in colour, glossy, thin, and transparent.

The species of *Limnea*, generally called "Pond Snails," are of an active disposition, and can achieve great feats in the way of eating aquatic plants. *L. peregra* is, probably, the commonest aquatic British Mollusc. The horn-coloured shell is oval in general outline; it has five convex whorls, the body-whorl being very large in comparison to the others. The shell is sharp at its apex, and its mouth is large; the length varies from half an inch to an inch. The "Freshwater Whelk," *L. stagnalis* (see Plate IX.), also common, has an elegant shell attaining a length from $1\frac{1}{2}$ to 2 inches. The body whorl is about three-fourths of the total length of the thin shell, and it is surmounted by several whorls forming a sharp, tapering spire; the colour is

(1)



(2)

(1) Various forms of Caddis "cases"

(2) Dragon-Fly resting. The insect is protected by the manner in which it harmonizes with its surroundings, rendering it not too readily observable

yellowish, or greyish-white. The animal lays over a hundred eggs, which are enclosed in a gelatinous capsule, on submerged plants.

The Limpets of the sea-shore are too well known to need description. We have two small freshwater species. *Ancylus fluviatilis* is found only in rivers and streams, but *A. lacustris* may be collected from the pond. The shell is yellowish or greenish, glossy, thin, and oblong in form, not more than quarter of an inch long. The animal has a green-tinged yellowish-grey body, with widely-separated pale grey tentacles. This species is to be found throughout Britain, but it is local in distribution.

CHAPTER VII

FISHES, AMPHIBIANS, BIRDS, AND MAMMALS

It remains, in this concluding chapter, to take a "peep" at some of the vertebrate animals that are associated with the pond. It will be hardly necessary to remind the reader that all the animals mentioned may not be found in any one pond some may be seen in one, others in another, while all might be absent from a third area of water. Seeing that birds can fly, and amphibians and mammals can walk, it is easy to account for their presence in any water; but to show how fishes have got into some ponds is not always easy. They may, in some cases, have been placed there by the agency of

man, or have got there by other agencies which we cannot discuss here.

The Common Carp (*Cyprinus carpio*) seems to have been introduced into Britain from Germany about the fifteenth century. It is a handsome, intelligent fish, which thrives in a suitable pond even better than in running streams. Anglers often call it the "freshwater fox," because it seems crafty enough to recognize the danger of their lures. It can endure great extremes of temperature, and will live out of water for hours. It may attain considerable size and weight, and, in favouring conditions, lives to a great age. In winter it is sluggish, and eats little. In colour, this fish is olive-brown, spangled with gold; beneath the body it is yellowish. There is a long brown fin on the back, and the other fins are similarly coloured. The small, toothless mouth has fleshy lips, and is furnished with two barbels. The food consists of young shoots of pond plants, insects, and small worms.

The Roach (*Leuciscus rutilus*), a relative of the Carp, thrives in some ponds. It is a stoutish fish, rather deep in the body, and averaging 9 or 10 inches in length. With its greenish-brown back, silvery sides and belly, and red fins, it is decidedly handsome.

A muddy pond, or old claypit filled with water, seems to suit the requirements of the Tench (*Tinca vulgaris*). As I write I have in my mind a pond, exceedingly muddy, from which I have drawn enough small Tench to fill a couple of buckets in a single day. Like the Carp, this sluggish fish clings to life with

great tenacity, and may be none the worse for several hours out of its element. The Tench is of a general olive colour, with whitish underneath the body. Other characteristics are—very small scales, sliminess to the touch, unforked tail, and mouth furnished with a pair of barbels. It may attain a weight of several pounds, and has a habit of burying itself in mud during winter.

Perhaps the Perch (*Perca fluviatilis*) is justifiably called the handsomest of our freshwater fish. He is dressed in a lovely combination of colours—red fins, deep-green back, shading into a greenish-yellow on the sides, striped transversely with broad, dark bands. The dorsal fin—that foremost on the back—is spiny. It is found in large ponds or lakes, where it may reach a weight of several pounds; those commonly caught in rivers, and even in lakes, are not of the largest size. I have caught many Perch, but not one over a pound in weight.

The Pike (*Esox lucius*), truly a "Water Wolf," needs no detailed description. It is to be found in many ponds, living at the expense of other fish, and any living creatures which it can swallow—with the exception of a toad.

But the commonest fish of the pond is the little Three-spined Stickleback (*Gasterosteus aculeatus*), which grows to a length of about 2 or 3 inches, and, as its name implies, has three sharp spines on its back. Much might be written about this pugnacious little fish, but the one point of outstanding interest is the paternal instinct of the male, which leads him to make a nest,

then seek a wife, and escort her to the home, there to deposit eggs. The home, with its precious contents, is faithfully guarded by the male, and when the young fish are hatched he watches them with anxious care until they are able to look after themselves. He will fight desperately on behalf of his charge, and when in warlike mood assumes his "war-paint," for then he simply scintillates in his dress of many hues.

As Mr. A. Nicol Simpson is writing a volume descriptive of all the British Reptiles and Amphibians for the "Peeps at Nature" Series, I shall not do more than mention the Amphibians here. As their name indicates, these animals have a double life. They begin their existence in water, issuing from eggs as tadpoles, which are, practically, fish; then they breathe by means of gills, as fish do. Later, they develop limbs, and leave the water for the land, where they are lung-breathers. But, either in water or air, the skin is always soft and moist, and capable of absorbing oxygen, so that the animals are not entirely dependent upon gills or lungs for respiration. All the British Amphibians may be looked for in the pond, especially in their tadpole stages, as well as in a more advanced condition. They include the Frogs, Toads, and Newts, or Efts. The Common Frog (*Rana temporaria*) is our only native species of its kind. Masses of its spawn are seen in ponds in the early spring. The Edible Frog (*Rana esculenta*) is an introduction, found principally in the eastern counties of England. The Toads have stouter bodies and shorter legs than Frogs. We have two species,

the Common Toad (*Bufo vulgaris*), and the Natterjack (*Bufo calamita*). Their eggs are laid in water in long chains. Toads are fonder of the land than Frogs ; they take to the water only briefly in the breeding season. Both Frogs and Toads are tailless in their adult stages, but the Newts retain their tails. They lay their eggs singly, not in chains or masses, and attach them one by one to water plants. They are not lacking in intelligence. We have three species, the Great Water Newt (*Molge cristata*), the Smooth Newt (*Molge vulgaris*), and the Palmated Newt (*Molge palmata*).

There are some Birds which we naturally associate with the pond, for instance the dainty black-and-white Pied Wagtail (Plate XIII.), which swings its tail up and down as it moves along the margin of the water, or over the floating water-lily leaves. Doubtless it is attracted by the good supply of insect food, to say nothing of the copious water-supply with which it can quench its thirst. The Moorhen is a common British bird, and may be seen swimming slowly in the pond, bobbing its neck and head curiously as it proceeds. It is quite at home on the ground, and in walking raises its tail at every step, displaying the white feathers underneath. The upper parts of this bird are dark olive-brown, and it is easily known by the bright red at the base of its bill, which, in summer, is tipped with yellow. The length is 13 inches. The nest, constructed of dry reeds and rushes, lined with sedges and grasses, is usually placed among rushes or sedges near, or even in, the water, but is sometimes found on a branch overhanging

the water, or under a bush. The sooty black Coot, with its white bill, a larger bird than the Moorhen, seems to favour large ponds, or lakes. The Dabchick, or Little Grebe, also frequents the pond. It is a dark brown, squat little bird, not more than 9 inches in length, that dives when alarmed. In winter it has a good deal of white about the under parts and neck.

FIG. 27.—WATER VOLE.

The nest consists of a good-sized mass of dead weeds. It often floats on the water, but is generally moored to reeds. Whenever the sitting bird leaves its nest, it covers the eggs with weeds.

Two Mammals which have formed aquatic habits may be looked for about the pond. The Water Vole (Fig. 27), often erroneously called a Water Rat, is

blackish in colour, the adult being about 8 inches in body length, and furnished with a 4-inch tail. It is of stouter build, and has a shorter tail, than a rat, and its ears are smaller. It makes a burrow in a bank, usually with one entrance below the surface of the water. It feeds on vegetation, and is an adept swimmer. One often sees it resting in absolute stillness on a ledge of the bank, but on being alarmed it dives into the water for safety, and swims away at a good pace. The little Water Shrew (Fig. 28) is the other mammal referred to. A typical specimen is black above and white underneath, about 3 inches in body length, with a 2-inch tail. It lives in a long burrow in the bank of a pond or stream; it feeds on Water-snails and insects, and may be seen swimming actively in many directions in quest of food, or diving with great ease. The Water Shrew is a timid animal, and dives on the least alarm, hastening to its natural retreat with all possible speed.

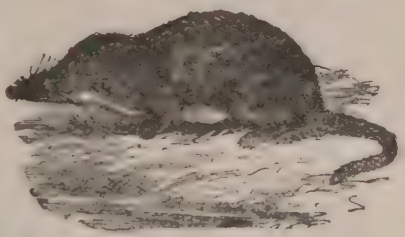


Fig. 28.—British Water Shrew.

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